14 Horticulture

TRIMESTER-WISE DISTRIBUTION OF COURSES

I TRIMESTER

		L	P
AGR 007	PRINCIPLES OF HORTICULTURAL CROPS	2	1
HORT 501	BASIC HORTICULTURE	3	2
HORT 502	NUTRITIONAL REQUIREMENT OF HORTICULTURAL CROPS	3	1
HORT 601/ PHT 601	EXPORT ORIENTED HORTICULTURE	3	1
FSC 501	FRUIT PRODUCTION-I	3	1
FSC 502	FUNDAMENTALS OF FRUIT PRODUCTION	4	1
FSC 601	PRODUCTION TECHNOLOGY OF PLANTATION CROPS	3	1
FSC 602	NATIONAL HORTICULTURAL PROBLEMS AND CURRENT ISSUES IN FRUIT PRODUCTION	4	0
VSC 501	PRINCIPLES OF VEGETABLE PRODUCTION	4	1
VSC 502	PRINCIPLES OF VEGETABLE BREEDING	4	1
VSC 601	HI-TECH VEGETABLE FARMING	3	1
FLA 501	FUNDAMENTALS OF FLORICULTURE	3	2
FLA 502	LANDSCAPE GARDENING	3	2
FLA 503	SPECIALTY FLOWERS AND CUT GREENS	2	1
FSC/VSC/ FLA 691	SEMINAR	1	0

II TRIMESTER

HORT 611	PROTECTED CULTIVATION OF HORTICULTURAL CROPS	3	1
FSC 511	FRUIT PRODUCTION-II	3	1
FSC 512	PLANT PROPAGATION	2	2
FSC 611	BREEDING OF FRUIT CROPS	4	1
VSC 511/ SST 511	PRINCIPLES AND TECHNIQUES OF VEGETABLE SEED PRODUCTION	4	1
VSC 512	WINTER VEGETABLES	3	1
VSC 513	PRODUCTION OF UNDERUTILIZED EXOTIC VEGETABLES	2	1
VSC 611	BREEDING OF CROSS-POLLINATED VEGETABLE CROPS	3	1
FLA 511	BREEDING OF ORNAMENTAL PLANTS	3	1

FLA 611	COMMERCIAL FLORICULTURE	3	1
FSC/VSC/ FLA 691	SEMINAR	1	0

III TRIMESTER

HORT 621/ PP 621	GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS	3	2
HORT 622	PLANT TISSUE CULTURE IN THE IMPROVEMENT OF HORTICULTURAL CROPS	2	2
FSC 521	SYSTEMATIC POMOLOGY	3	1
VSC 521	SUMMER VEGETABLES	3	1
VSC 621	BREEDING OF SELF-POLLINATED VEGETABLE CROPS	3	1
VSC 622	BIOTECHNOLOGY FOR VEGETABLE CROPS IMPROVEMENT	3	1
FLA 521/ SST 521	PLANTING MATERIAL AND SEED PRODUCTION IN FLOWER CROPS	2	1
FLA 522	INDOOR PLANTS	3	1
FLA 621	ADVANCED BREEDING OF ORNAMENTAL CROPS	3	1
FLA 622/ PHT 622	VALUE ADDITION IN ORNAMENTAL CROPS	1	1
FSC/VSC/ FLA 691	SEMINAR	1	0

Core Courses

M.Sc.: HORT 501
FSC 501, FSC 502, FSC 512, HORT 502
VSC 501, VSC 502, VSC 512, VSC 521
FLA 501, FLA 502, FLA 511, FLA 521

Ph.D.: FSC 602, FSC 611, HORT 621
VSC 601, VSC 611, VSC 621, VSC 622
FLA 611, FLA 621, FLA 622, HORT 621

Outside the discipline core courses for students of Hortiulture Science
(Fruit Science – FSC, Vegetable Science – VSC and Floriculture and Landscape Architecture – FLA)

1. **Courses from Crop Improvement School**
   a. **Genetics**
      I. **GP 500:** Elements of Genetics (3L+2P),
      II. **GP 510**: Principles of Cytogenetics (3L+2P)
   b. **Postharvest Management**
      PHT 503: Laboratory Techniques for Food Crops (2L+2P)

2. Courses from Resource Management School

a. Agronomy

I. AG 503: Principles and Practices of Weed Management (3L+1P) and

II. AG 602: Modern Concepts in Agronomy (3L+1P)

b. Agricultural Physics

I. AP 640: Remote Sensing in Agriculture (2L+1P)

II. AP 541: GIS and GPS- Principles and Application (2L+1P)

3. Courses from Basic Sciences School

a. Molecular Biology and Biotechnology

I. MBB 501: Principles of Biotechnology (3L+0P),

II. MBB 502: Fundamentals of Molecular Biology (3L+0P)

III. MBB 509: Bioinformatics (2L+1P)

IV. MBB 601: Molecular Breeding (3L+0P)

b. Plant Physiology

I. PP 501: Principles of Plant Physiology-I (4L+1P)

II. PP 505: Physiology of Growth and Yield (2L+1P)

III. PP 508: Physiology of Plant Mineral Nutrition (3L+2P)

c. Biochemistry

I. BIO 501: Basic Biochemistry (4L+1P)

II. BIO 502: Nutritional Biochemistry (3L+1P)

III. BIO 601: Nucleic Acids (2L+1P)

IV. BIO 503: Plant Biochemistry (3L+1P)

V. BIO 504: Techniques in Biochemistry (2L+2P)

HORTICULTURE

FRUIT SCIENCE - FSC
VEGETABLE SCIENCE - VSC
FLORICULTURE AND LANDSCAPE ARCHITECTURE - FLA

Name of School : Crop Improvement

Major Fields : Floriculture and Landscape Architecture

Fruit Science

Vegetable Science

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

M.Sc. student shall have to take one minor (9 credits of course work) from any other disciplines outside his/her own discipline.

DESCRIPTION OF COURSES

GENERAL COURSES ON HORTICULTURE (HORT)

AGR 007 PRINCIPLES OF HORTICULTURAL CROPS (2L+1P) I

Objective

To impart basic knowledge about the principles of production of horticultural crops.

Theory

UNIT I

Layout and establishment of orchards, kitchen and flower gardens; growing plants in pots.

UNIT II

Vegetable growing, climatic, soil and cultural requirements of major horticultural crops, varieties, crop rotation.

UNIT III

Canopy management in fruit crops, manures and fertilizers, irrigation, major pests and diseases, weed control, methods of propagation and seed production, crop maturity and yields in horticultural crops.

Practicals

Classification of vegetables; Healthy nursery raising in vegetables; Layout of a model kitchen garden, fruit orchard and flower garden; Propagation in fruit crops and important flower crops.

Suggested Readings

Chadha, K.L. 2002. Handbook of Horticulture, ICAR, New Delhi.

Choudhary, B. 1985. Vegetables. National Book Trust, New Delhi.

Sawaroop, Vishnu. 1989. Ornamental Crop. National Book Trust, New Delhi.

Singh, Ranjit. 1987. Fruit Crops. National Book Trust, New Delhi.

Manibhushan, K. Rao. 1991. Text Book of Horticulture. MacMillan India Ltd., New Delhi.

HORT.501 BASIC HORTICULTURE (3L+2P) I

Objective

To impart basic knowledge about the importance and management of different horticultural crops.

Theory

UNIT I

Layout of orchards, their establishment and maintenance; principles of planting, training and pruning; propagation, manure and fertilizer application; irrigation and plant protection measures; Production technology of important fruit crops.

UNIT II

Nutritive value of fruits and vegetables, causes of spoilage of fruits and vegetables and their control measures; principal methods of preservation; commercial fruit and vegetable products; processing equipment.

UNIT III

Vegetable cultivation in India, types of vegetable growing; cultural practices for important vegetable crops.

UNIT IV

Importance, scope and principles of floriculture and landscaping; different styles and designs of garden; their features and maintenance; landscaping of public places including their plan and planting material. Production technology of important flower crops.

Practicals

Nursery management and polyhouse culture; Visit to vegetable farms and nursery, identification of seasonal vegetables; Enzyme test and dehydration of fruits and vegetables; Estimation of acidity and sugars in fruits and vegetables; Preparation of juice and jam; Preparation of nectar and squashes; Systematic description of fruit crops and their propagation; Layout and planting system of orchards; Fertilizer and water use in orchard; Visit to various gardens and identification of ornamental plants.

Suggested Readings

Adams, C.R. and Early, M.P. 2004. Principles of Horticulture. Butterworth-Heinemam, Oxford University Press.

Bhattacharjee, S.K. and De, L.C. 2007. Post Harvest Technology of Flower and Ornamental Plants, New Age India, Jaipur.

Bose, T.K. and Yadav, L.P. 1989. Commercial Flowers. Naya Prokash, Kolkata.

Chadha, K.L. and Choudhury, B. 1992. Ornamental Horticulture in India. ICAR, New Delhi.

Chadha, K.L. 2001. Handbook of Horticulture, ICAR, New Delhi.

Christopher, E.P. 2001. Introductory Horticulture, Biotech Books, New Delhi.

Cruess, W.V. 1997. Commercial Fruit and Vegetables Products, Agro Botanica, Bikaner, Rajasthan.

Edmond, J.B., Senn, T.L., Andrews, F.S. and Halfacre, P.G. 1975. Fundamentals of Horticulture, Tata McGraw Hill Publishing Co. New Delhi.

Sandhu, A.S. and Bal, J.S. 2002. Post Harvest Handling of Fruits and Vegetables. Punjab Agricultural University, Ludhiana.

Srivastava, R.P. and Sanjeev Kumar. 1998. Fruits and Vegetable Preservation Principles and Practices. International Book distributing Co. Chapman studio building, 2nd floor, Charbagh, Lucknow, UP.

HORT 502 NUTRITIONAL REQUIREMENT OF HORTICULTURAL CROPS (3L+1P) I

Objective

To acquaint students about the role of different nutrient elements in plant growth and development, principles and practices of fertilizers and manures application and their management in production of different horticultural crops.

Theory

UNIT I

Essential elements identified as plant nutrients, Factors affecting plant nutrition; nutrient uptake and their removal from soil.

UNIT II

Nutrient requirements of major fruits and vegetables.

UNIT III

Methods and techniques for evaluating the requirement of macro- and micro-elements, role of different macro- and micro-nutrients, their deficiency and toxicity disorders, corrective measures to overcome deficiency and toxicity disorders.

UNIT IV

Soil and foliar application of nutrients in major horticultural crops.

UNIT V

Fertigation in horticultural crop, bio-fertilizers and their use in IPNM systems.

Practicals

Visual identification of nutrient deficiency symptoms in vegetable/ annual crops; Identification of organic, inorganic and bio-fertilizers and methods of application; Soil and tissue sample collection, preparation for macro- and micro-nutrient analysis; Analysis of soil physical and chemical properties. Soil pH, EC, Organic carbon determination in soil; 'P' analysis using spectrophotometer; 'N' analysis using auto analyzer; 'K' & 'Na' analysis using flame photometer; Ca, Mg, Fe and Zn analysis using Atomic absorption spectrophotometer; Visual identification of nutrient deficiency symptoms in fruit crops; Visual identification of nutrient deficiency symptoms in flowers, vegetable crops; Fertigation in glasshouse and field grown horticultural crops; Preparation of micro-nutrient solutions, their spray and soil applications.

Suggested Readings

Bould, C., Hewitt, E.J. and Needham, P. 1983. Diagnosis of Mineral Disorders in Plants Vol.1 Principles. Her Majesty's Stationery Office, London.

Cooke, G.W. 1972. Fertilizers for maximizing yield. Grenada Publishing Ltd, London.

Epstein, E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. Wiley Eastern Ltd.

Kanwar, J.S. 1976. Soil Fertility- Theory and Practice. ICAR, New Delhi.

Marchner, Horst. 1995. Mineral Nutrition of Higher Plants, 2nd ed. Marschner, Academic Press Inc. San Diego, CA.

Mengel, K. and Kirkby, E.A. 1987. Principles of Plant Nutrition. 4th ed. International Potash Institute, Worblaufen-Bern, Switzerland.

Mitra, S.K., Sadhu, M.K. and Bose, T.K. (ed.). 1990. Nutrition of Vegetable Crops. Naya Prokash, Kolkata.

Scaife, Alan and Turner, Mary. 1983. Diagnosis of Mineral Disorders in Plants Vol. 2 Vegetables. Her Majesty's Stationery Office, London.

Tandon, H.L.S. 1992. Management of Nutrient Interactions in Agriculture Fertilizer Development and Consultation Organization, New Delhi.

Westerman, R.L. (ed.) 1990. Soil Testing and Plant Analysis, 3rd. edition. Soil Science Society of America, Inc., Madison, WI.

Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 1972. Manures and Fertilizers. Third revised edn. Agri Horticultural Publishing House, Nagpur.

HORT 601/ PHT 601 EXPORT ORIENTED HORTICULTURE (3L+1P) I

Objective

To acquaint students with the export oriented requirements of horticultural crops.

Theory

UNIT I

India's position and potentiality in world trade; export promotion zones in India.

UNIT II

Scope, produce specifications, quality and safety standards for export of fruits *viz.*, mango, grape, litchi, pomegranate, walnut, cashewnut *etc.*, vegetables *viz.*, onion, chilli, okra, bitter gourd, gherkin *etc.* flowers *viz.*, rose, carnation, chrysanthemum, gerbera, specialty flowers *etc.*, cut greens and foliage plants.

UNIT III

Processed and value-added products, post harvest management for export including packaging and cool chain; HACCP, Codex alimentarius, ISO certification; WTO and its implications, sanitary and phyto-sanitary measures.

UNIT IV

Seed and planting material; Hi-tech nurseries, implications of PVP.

Practicals

Export promotion zones for vegetables and export of fresh vegetables and their products; Quality standards of vegetables for export purpose; Practical on quality standards of major flowers for export; Quality standards of planting material and seeds; Hi-tech nursery in floriculture; Quality standards of major fruits for exports; Practical on ISO specifications and HACCP for export of fruits; Sanitary and phytosanitary measures during export of horticultural produce; Post harvest management chain of horticultural produce for exports.

Suggested Readings

Bartz, J.A. and Brecht, J.K. 2002. Post Harvest Physiology and Pathology of Vegetables (IInd Ed.) Marcel Dekkar, Inc., New York.

Bhattacharjee S.K. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ.

Bose, T.K. and Yadav, L.P. 1989. Commercial Flowers. Naya Prokash, Kolkata.

Bose, T.K, Maiti, R.G., Dhua, R.S. and Das, P. 1999. Floriculture and Landscaping. Naya Prokash, Kolkata.

Chadha, K.L. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ. House, New Delhi.

Islam, C.N. 1990. Horticultural Export of Developing Countries: Past Preferences, Future Prospects and Policies. International Institute of Food Policy Research, USA.

Reddy, S., Janakiram, T., Balaji, T., Kulkarni, S. and Misra, R.L. 2007. Hi-tech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.

Sheela, V.L. 2007. Flowers in Trade. New India Publ. Agency, New Delhi.

HORT 611 PROTECTED CULTIVATION OF HORTICULTURAL CROPS (3L+1P) II

Objective

To impart knowledge on agro-technique and management of different horticultural crops under protected environmental conditions.

Theory

Objectives, importance and scope of protected cultivation of vegetables, fruits and ornamental plants; principles and structures used in protected cultivation including hotbed, cold frame, polyhouse, low tunnel *etc.*; effect of temperature, light, humidity and CO_2 on growth, flowering and production; hi-tech nursery raising technology of vegetables and flowers and propagation of fruit crops; selection of crops and varieties, production technology and economics of production of high value crops;

UNIT I

Vegetables like tomato, cucumber, capsicum, melons, summer squash.

UNIT II

Ornamental crops like rose, chrysanthemum, carnation, gerbera, lilium, orchids, anthuriums.

UNIT III

Fruit crops like strawberry and raspberry.

UNIT IV

Micro-irrigation, fertigation and soil-less culture; manipulation of conditions for staggering production; problems associated with growing of horticultural crops in greenhouse and their remedies; use of greenhouse for seed production; growth regulators for manipulation of growth and flowering in ornamentals; post-harvest management of greenhouse grown commodities.

Practicals

Layout and installation of different protected structures; Climatic requirements maintenance for protected cultivation of horticultural crops; Hi-tech nursery raising technology for vegetables; Hi-tech nursery raising technology for ornamental crops; Laying of plastic low tunnels for off-season vegetable cultivation; Tissue culture and hi-tech nursery management for fruit crops; Production and management of greenhouse flower crops; Fertigation technology for horticultural crops; Soilless cultivation of horticultural crops; Training, pruning and trellising in greenhouse vegetables; Commercial propagation of orchids and anthurium; Post-harvest management of horticultural produce and on farm value addition.

Suggested Readings

Boodley, James W. 1981. The Commercial Greenhouse. Ball Publishing, USA.

Burt, C., Conoor, K.O. and Rueshr, T. 1998. Fertigation: Published by Irrigation Training and Research Centre, California Polytechnic State University, San Wis O Bispo, CA.9340.

Hanan, J.J. 1998. Greenhouses: Advanced Technology for Protected Horticulture. CRC Press, New York.

Hickman, G.W. 1998. Commercial Greenhouse Vegetable Handbook. University of California, USA.

Jones, J.B. Jr. 2005. Hydroponics: A Practical Guide for the Soilless Growers (Second ed.) CRC Press, USA.

Manohar Radha K. and Igathanathane, C. 2000. Greenhouse Technology and Management. BSP. BS Publication, Hyderabad.

Prasad, S. and Kumar, V. 1999-2000. Green House Management for Horticultural Crop Production. Agrobios (India), Jodhpur.

Singh, Balraj 2005. Protected Cultivation of Vegetable Crops. Kalyani Publishers, New Delhi.

Singh, Balraj and Singh, M.C. 2007. Protected Cultivation of Horticultural Crops: A Practical Manual: Department of Horticulture, IARI, New Delhi.

Taft, L. 1997. Greenhouse Management, Forcing of Flowers, Vegetables and Fruits. Daya Publishers House, New Delhi,

HORT 621/PP 621 GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS (3L+2P) III

Objective

To teach about the growth and development processes of horticultural crops, knowledge of basic physiological and molecular processes affecting growth, flowering and production of quality produce.

Theory

UNIT I

Defining growth and development; physical and physiological aspects of growth, germination, juvenility; root and leaf differentiation.

UNIT II

Flowering, fruit set and development, fruit maturity and ripening, abscission, senescence of horticultural crops; factors influencing flowering, photoperiodism, vernalisation, effect of temperature, heat units, thermoperiodism.

UNIT III

Biosynthesis of auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassino-steroids, synthetic growth inhibitors, morphactins, methyl jasmonates, salicylic acid, polyamines etc. their mode of action.

UNIT IV

Role of plant growth promoters and inhibitors on physiological processes like seed and bud dormancy, fruit thinning, fruit drop, sex expression/ modification in cucurbits and induction of parthenocarpy; plastochrome.

UNIT V

Water relations, stress physiology in relation to drought, temperature and salts, quality improvement in fruits, vegetables and flowers.

Practicals

Visit to Physiology laboratory; Testing of seed germination and breaking dormancy in seeds; Study on fruit set and fruit growth; Estimation of tissue macro- and micro-nutrients; Estimation of enzymes; Estimation of chlorophyll, carotenoids and other pigments; Bioassay of plant hormones; Use of HPLC and GC for estimation of phyto-hormones; application of GRs in fruit thinning and control of fruit drop; sex expression and induction of parthenocarpy in horticultural crops; use of PGRs in ornamental crops; Light manipulation in protected cultivation.

Suggested Readings

Bleasdale, J.K.A. 1984. Plant Physiology in Relation to Horticulture. 2nd Ed. McMillan & Co.

Fosket, D.E. 1994. Plant Growth and Development: a Molecular Approach. Academic Press, New York.

Fosket, D.E. 1994. Plant Growth and Development: a Molecular Approach. Academic Press, USA.

Krishnamurthy, H.N. 1993. Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.

Leoplod, A.C. and Kriedermann, P.E. 1985. Plant Growth and Development. 3rd Ed. Mc Graw-Hill, London.

Moore, T.C. 1979. Biochemistry and Physiology of Plant Hormone. Springer-Verlag, New York, USA.

Nickell, L.G. 1983. Plant Growth Regulating Chemicals. CRC Press, New York.

Noggle, Ray G. and Fritz, G.J. 1991. Introductory Plant Physiology. Prentice Hall of India Pvt. Ltd., New Delhi.

Peter, K.V. 2008. Basics of Horticulture (Ed.). New India Publ. Agency, New Delhi.

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

Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology. 4th Ed. Wordsworth Publ.

Taiz, L. and Zeiger, E. 2006. Plant Physiology. Sinauer Associates, Inc., Massachusetts, USA.

HORT 622 PLANT TISSUE CULTURE IN THE IMPROVEMENT OF HORTICULTURAL CROPS (2L+1P) III

Objective

To familiarize the students and provide hands-on training on various techniques of plant tissue culture and their applications in improvement of horticultural crops.

Theory

UNIT I

Basic principles of plant tissue-culture; morphogenetic potential of higher plants and regeneration pathways.

UNIT II

Application of plant tissue culture techniques in crop improvement with emphasis on ornamental, fruit and vegetable crops, single cell and suspension culture, *in vitro* mutagenesis, somaclonal variation, embryo culture and rescue, anther culture and haploid production.

UNIT III

Protoplast isolation, fusion and organogenesis, *Agrobacterium*-mediated genetic transformation and cryobiology.

UNIT IV

In vitro germplasm conservation, genetic diversity analysis using DNA markers.

Practicals

General acquaintance with a tissue culture laboratory; Methods of aseptic culture and sterilization procedure; Stock solutions and preparation of culture media; *In vitro* culture establishment and plant regeneration, Embryo culture and embryo rescue; Anther isolation and culture; *In vitro* mutagenesis using EMS and gamma irradiation; *In vitro* screening for NaCl tolerance; *Agrobacterium*-mediated genetic transformation of tobacco; DNA isolation and RAPD analysis of plants; Techniques of low temperature germplasm storage, cryo-preservation and visit to NBPGR cryo-bank.

Suggested Readings

Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J. and Jayamaran, K. 1998.

Bojwani, S.S. and Razdan, M.K. 1983. Plant Tissue Culture: Theory and Practices, Elsevier, Amsterdam.

Chadha, K.L., Ravindran, P.N. and Sahijaram, Leela 2000. Bio-technology in Horticulture and Plantation Crops. Malhotra Publishing House, New Delhi.

Concepts in Biotechnology. University Press, India.

Gupta, P.K. 1999. Elements of Biotechnology, Rastogi publications, Meerut, India.

Hammerscchlag Z.A. and Litz, R.E. 1997. Biotechnology of Fruit and Nut Crops, CABI, U.K.

Primrose, S.B. 1987. Modern Biotechnology. Blackwell Scientific Co., USA.

Razdan, M.K. 1993. An Introduction to Plant Tissue Culture. Oxford & IBH, Publishing Co. Pvt. Ltd., New Delhi.

Singh, B.D. 1999. Biotechnology, Kalyani Publishers, Ludhiana.

Street, H.E. 1973. Plant Tissue and Cell Culture. Blackwell Publications, London.

Vasil, I.K. 1967. Cell Culture and Somatic Cell Genetics. Academic Press, London.

FRUIT SCIENCE (FSC)

FSC 501 FRUIT PRODUCTION-I (3L+1P) I

Objective

To impart basic knowledge about the importance, management and latest production techniques in tropical and sub-tropical fruits grown in India.

Theory

Origin, history, soil, climate, cultivars, propagation, canopy management, nutrition, irrigation scheduling, important pests and diseases, major physiological disorders- causes and remedies, quality improvement practices; maturity indices, harvesting, grading, packaging, storage and ripening techniques concerned with the cultivation of important tropical, sub-tropical and temperate fruits, GAPs and organic fruit production systems.

UNIT I
Mango, banana, papaya, cashews.

UNIT II
Citrus, grape, guava.

UNIT III
Coconut, sapota.

UNIT IV
Apple, pear, peach, plum, cherry.

UNIT V
Almond and walnut.

Practicals

Planning, layout and establishment of fruit orchard; Visit to germplasm block of mango, grape and citrus; Propagation of quality planting material in different fruit crops, technique of budwood certification and nursery management; Management of frost and high temperature in fruit crops; Intercropping and mulching in fruit crops; High density planting in fruit crops; Rejuvenation of senile fruit orchards; Methods of irrigation and fertigation; Pruning and training technique of tree and vine crops ; Identification of important fruit varieties/roostocks; Identification of important pests and diseases of fruit crops; National problems of important fruit crops and their management.

Suggested Readings

Bose, T.K., Mitra, S.K. and Sanyal, D. 2001. Fruits: Tropical and Subtropical, Vol. I. Naya Udyog, Kolkata.

Chadha, K.L. and Pareek, O.P. 1997. Advances in Horticulture Vol. 4. Malhotra Publishing House. New Delhi.

Chadha, T.R. 2001. Textbook of Temperate Fruits. ICAR, New Delhi.

Childers, N.F. 1999. Modern Fruit Science: Orchard and Small Fruit culture, Freeman, USA.

Davis, F.S. and Albrigo, L.G. 1994. Citrus, CABI, UK.

Jackson, D.I. and Looney, N.E. 1999. Temperate/Subtropical Fruit Production, CABI, UK.

Litz, R.E. 1999. Mango, Botany, Production and Utilization, CABI, UK.

Mitra, S.K., Rathore, D.S. and Bose, T.K. 1991. Temperate Fruits. Horticulture and Allied Publishers, Kolkata.

Nakasone, H.Y. and Paul, R.E. 1998. Tropical Fruits. CABI, UK.

Robinson, J.C. 1996. Banana and Plantain, CABI, U.K.

Shanmugavelu, K.G. 1987. Production Technology of Fruit Crops. SBA Publications, Coimbatore.

FSC 502 FUNDAMENTALS OF FRUIT PRODUCTION (4L+1P) I

Objective

To teach the principles of fruit growing, effects of different factors on production and produce quality, effective management of different resources, and techniques of pre- and post-harvest of different fruits.

Theory

UNIT I

Orchard layout principles, Soil and climatic adaptation of different fruit crops.

UNIT II

Occurrence of frost and protection against frost; winter injury in relation to specific fruits, water requirement of fruit crops, intake and utilization of water; response of fruit plants to varying conditions of soil moisture and humidity and pathological conditions associated with excess and deficiency of moisture.

UNIT III

Soil management practices; manures and manuring; systems of cultivation, intercrops, cover crops and mulching.

UNIT IV

Growth and fruiting habits; principles, severity, methods and season of pruning with special reference to major fruits; training methods.

UNIT V

Unfruitfulness associated with internal and external factors; factors concerned with development of fruit, fruit setting as an orchard problem; alternate or irregular bearing; Fruit thinning and fruit drop.

UNIT-VI

Harvesting; pre-cooling, grading, packing and transport; marketing and local market surveys.

Practicals

Identification of fruit plants; Preparation of herbarium; Layout of orchard and nursery; Layout of irrigation systems, preparation of spray solutions and maintenance of sprayers; Methods of application of fertilizers and manures and calculation of fertilizer doses; Training and pruning systems in fruit crops; Rejuvenation of unproductive trees; Strategies to control sun-scalding and frost; Vegetative propagation of fruit plants.

Suggested Readings

Childers, N.F. 1983. Modern Fruit Science: Orchard and Small Fruit Culture, Freeman, USA.

Denisen, E.L. 1959. Principles of Horticulture. MacMillan Pub. Co. New York.

Gardener, V.R., Bradford, F.C. and Hooker, H.D. 1952. Fundamentals of Fruit Production. McGraw Hill, New York.

Gourley. J.H. and Howbeth, F.S. 1941. Modern Fruit Production. MacMillan Pub. Co. New York.

Jackson, M.L. and Looney, N.E. 1999. Temperate/Subtropical Fruit Production. CABI, UK

Janick, J.J. 1986. Horticultural Science. 4th Ed. WH Freeman & Co. New York

Janick, Jules (ed.) Horticultural Reviews, AVI, Publishers, Connetient, USA.

Lerner, H.R. 1999. Plant Responses to Environmental Stresses, Marcel Dekker.

Mussell, H. and Staples, R. 1979. Stress Physiology in Crop Plants. Wiley Inter Science.

Prasad, S. and Kumar, U. 2005. Principle of Horticulture. 3rd edition, Agrobios, Jodhpur.

Turener, N.C. and Kramer, P.J. 1980. Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons.

FSC 511 FRUIT PRODUCTION-II (3L+1P) II

Objective

To acquaint the students with the importance and management of tropical, sub-tropical and dryland fruits grown in India.

Theory

Importance and nutritional properties of minor fruit crops, Suitability of crops for arid, saline and alkaline, high moisture regimes, cultivation technologies of some minor and under utilized fruit crops.

UNIT I

Ber, sapota, mangosteen.

UNIT II

Litchi, pomegranate, date, avocado, *kokum*.

UNIT III

Loquat, fig, *phalsa*, jackfruit, custard apple.

UNIT IV

Bael, *aonla, jamun*, carambola.

UNIT V

Pineapple, passion fruit, persimmon, kiwifruit, strawberry, raspberry, etc.

Practicals

Introduction and classification of minor and arid fruit crops; Propagation and nursery management in different fruit crops; Micro-irrigation in fruit crops; Efficient spray technologies for fruit crops; Special problems of fruit production; International market standards of fruit crops; Visit to the commercial orchards and nurseries; Economics of production of few important fruit crops.

Suggested Readings

Bose, T.K., Mitra, S. and Sanyal, D. 2002. Fruits: Tropical and Subtropical. Vol. 2, Naya Udyog, Kolkata.

Bose, T.K., Mitra, S.K. and Rathore, D.S. (Eds.). 1988. Temperate Fruits, Allied Publ., New Delhi.

Chadha, K.L. and O.P. Pareek. 1997. Advances in Horticulture Vol. 1 to 4, Malhotra Publishing House, New Delhi.

Chundawat, B.S. 1995. Arid Fruit Culture. Oxford IBH, New Delhi.

Janick, Jules (ed.). Horticultural Reviews, AVI Press, USA.

Nakasone, H.Y. and Paull, R.E. 1998. Tropical Fruits. CABI, UK.

Vishal Nath, Dinesh Kumar and Pandey, V. 2007. Fruits for the Future Vol. I Well Versed Arid and Semi-Arid Fruits. Satish Serial Pub. House, Azadpur, New Delhi.

FSC 512 PLANT PROPAGATION (2L+2P) II

Objective

To teach the students the principles and practices of propagation and nursery management of horticultural crops.

Theory

UNIT I

Fundamental principles of plant propagation, Propagation structures like cold frame, hot beds, etc. use of plant regulators in propagation; techniques of propagation and equipment.

UNIT II

Seed dormancy and germination, propagation by different specialized plant parts, cutting, layering and grafting; Propagation of annuals through seeds, plug plants production.

UNIT III

Physiological, anatomical, biochemical and genetical basis of rooting, Stionic influence; incompatibilities; rootstocks for fruit crops.

UNIT IV

Techniques of micropropagation, shoot tip grafting and meristem culture, micro-budding, synthetic seed, commercial methods of propagation in different horticultural crops. Commercial tissue culture laboratories and Nursery sector in the country.

UNIT V

Scion bank and Hi-tech nursery, Nursery and seed Acts, Nursery registration, IPR issues related with vegetatively propagated horticultural crops.

Practicals

Layout of nursery and propagation structures; Ideal nursery soil: Different types of propagation media, soil mix and amendments; Preparation of nursery beds, filling of pots and soil treatments; Use of growth regulators in plant propagation, preparation of solutions and pastes; Scarification and stratification, Seed propagation of perennial and annual horticultural crops; Propagation by specialized stem and roots; Propagation of plants by cuttings; Propagation of plants by air-layering; Propagation in guava by stooling; Practice of propagation by other layering methods; Practice of different methods of budding; Visit of commercial nurseries; Glasshouse and greenhouse establishment and their maintenance; Micropropagation techniques: *In vitro* propagation grape and citrus; Micro-budding and shoot tip grafting in citrus.

Suggested Readings

Adams, C.R., Bandford, K.M. and Gourley, M.P. 1996. Principles of Horticulture. CBS Publishers and Distributors, New Delhi.

Bose, T.K., Mitra, S.K., Sadhu, M.K., Das, P., Sanyal, D. and Parthasarathy, V.A. 2005. Propagation of Tropical and Subtropical Horticultural Crops, Vol. I. Naya Udyog, Kolkata, 662 p.

Garner, R.J. 1993. The Grafter's Handbook. Sterling Publishing Co. Inc.

Hartmann, H.T., Kester, D.E., Davies, F.T. and Geneve, R.L. 2002. Hartmann and Kesters's Plant Propagation: Principles and Practices, 7th edn. Prentice Hall of India, New Delhi.

Macdonald, B. 1986. Practical Woody Plant Propagation for Nursery Growers. Timber Press, Inc.

Nanda, K.K. and Kochhar, V.K. 1995. Vegetative Propagation of Plants. Kalyani Publishers, New Delhi.

Sadhu, M.K. 1989. Plant Propagation. Wiley Eastern Ltd., New Delhi.

Sharma, R.R. 2002. Plant Propagation, Kalyani Publishers, Ludhiana.

FSC 521 SYSTEMATIC POMOLOGY (3L+1P) III

Objective

To familiarize students about the taxonomy, classification, nomenclature and descriptor of different fruit crops.

Theory

UNIT I

History of nomenclature of plants, classification and nomenclature systems.

UNIT II

International Code of Nomenclature for cultivated plants; identification features, plant keys, registration, description and classification of mango, banana, grape, citrus, guava, *ber*, *aonla*, papaya, apple, pear, peach, plum, almond, sapota, cashewnut, pomegranate and date palm.

UNIT III

Fruit crop descriptors and nomenclature.

UNIT IV

Molecular techniques in modern systematics.

Practicals

Different nomenclature systems of plants; Floral biology and taxonomic description of (a) mango; (b) citrus; (c) grape; (d) guava; (e) *ber*; (f) papaya; (g) banana; (h) apple; (i) pear; (j) peach; Visit to field gene-banks of mango, citrus and grape; Pollen collection, viability, and storage; Cyro-preservation and tissue culture repository; Herbarium preparation of different fruit crops; Techniques of molecular systematics; visit to NBPGR.

Suggested Readings

Bhattacharya, B. and Johri, B.M. 2004. Flowering Plants: Taxonomy and Phylogeny. Narosa Pub. House, New Delhi.

Dutta, A.C. 1986. A Class Book of Botany. Oxford Univ. Press, Kolkata.

Pandey, B.P. 1999. Taxonomy of Angiosperm. S. Chand & Co.

Rajput, C.B.S. and Haribabu, R.S. 2006. Citriculture, Kalyani Publishers, New Delhi.

Spencer, R.R. Cross, R. and Lumley, P. 2003. Plant Names 3rd Ed. A Guide to Botanical Nomenclature, CISRO, Australia.

Srivastava, U, Mahajan, R.K., Gangopadyay, K.K., Singh, M. and Dhillon, B.S. 2001. Minimal Descriptors of Agri-Horticultural Crops. Part-I: Fruits. NBPGR, New Delhi.

Stover, R.H. and Simmonds, N.W. 1991. Bananas. Orient Longman, New Delhi.

Vasistha, B.B. 1998. Taxonomy of Angiosperm. Kalyani Publishers, New Delhi.

FSC 601 PRODUCTION TECHNOLOGY OF PLANTATION CROPS (3L+1P) I

Objective

To impart basic knowledge on the importance and production techniques in plantation crops grown in India.

Theory

Plantation crops and their role in national economy. Classification and varietal wealth. Climatic and soil requirements. Species, origin and cytogenetics, blossom biology, breeding objectives, approaches for crop improvement. Propagation, planting systems, multi-tier cropping, inter- and cover crops, effect of excess or low rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, training and pruning, crop regulation, special cultural operations, physiological disorders, role of growth regulators, irrigation requirements, weed management, maturity indices, harvesting, processing and value addition. Organic and precision farming, seed gardens.

UNIT I

Cashew and cocoa.

UNIT II

Coconut, arecanut.

UNIT III

Tea, coffee and rubber.

UNIT IV

Oil palm and palmyrah palm.

Practicals

Botanical description of plantation crops and varietal features; Criteria for selection of potential mother trees/palms, selection of planting material in coconut and arecanut, planting systems, pit preparation, manuring and floor management practices; Pruning and training techniques, special operation, use of PGRs, maturity standards and harvest index; Preparation of multi-storied cropping system models, visit to plantations.

Suggested Readings

Bose, T.K., Mitra, S.K. and Sanyal, D. (Ed.). 2002. Fruits of India- Tropical and Sub-tropical. 3rd Ed. Vols. I & II. Naya Udyog, Kolkata.

Bose, T.K., Mitra, S.K., Farooqi, S.K. and Sadhu, M.K. (Eds.) 1999. Tropical Horticulture. Vol.I. Naya Prokash, Kolkata.

Chadha, K.L. 2002. Handbook of Horticulture, ICAR, New Delhi.

Chadha, K.L. and Rethinam, P. (Eds.). 1993. Advances in Horticulture. Vol. IX. Plantation Crops and Spices. Part-I. Malhotra Publ. House, New Delhi.

Chopra, V.L. and Peter, K.V. 2005. Handbook of Industrial Crops. Panima Books, New Delhi.

Kurian, A. and Peter, K.V. 2007. Commercial Crops Technology. New India Publ. Agency, New Delhi.

Kurian, Alice and Peter, K.V. 2007. Commercial Crops Technology: Vol. 8. Horticulture Science Series, New India Publishing, New Delhi.

Peter, K.V. 2002. Plantation Crops. National Book Trust, New Delhi.

Shanmugavelu, K.G., Kumar, N. and Peter, K.V. 2002. Production Technology of Spices and Plantation Crops. Agrobios, Jodhpur.

Srivastava, H.C., Vatsaya, B. and Menon, K.K.G. 1986. Plantation Crops- Opportunities and Constraints. Oxford & IBH, New Delhi.

Thampan, P.K. 1981. Handbook of Coconut Palm. Oxford & IBH, New Delhi.

FSC 602 NATIONAL HORTICULTURAL PROBLEMS AND CURRENT ISSUES IN FRUIT PRODUCTION (4L+0P) I

Objective

To teach the students about the present situation of the different problems confronting fruit production and strategies to manage them.

Theory

UNIT I

National and international scenario in fruit production and trade. Climate change and fruit production. Abiotic and biotic factors influencing production, productivity and fruit quality.

UNIT II

Senile and seedling orchards- Replant problems and top working, *in-situ* rain water harvesting and enhancing water use efficiency, Nutrient and irrigation scheduling, Fruit crop based cropping systems, pesticidal residues and MRLs issues in fresh produce.

UNIT III

GAPs in fruit production, HiTech banana & citrus production, Quality grape production in sub-tropical regions, crop regulation in pomegranate and guava, Quality plant material.

UNIT IV

Complex problems confronting fruit cultivation and their management: Alternate bearing in mango & apple, mango malformation, panama wilt of banana, citrus decline, guava wilt, coconut wilt, apple scab, chilling and pollination problems in temperate fruits, frost and virus problems in papaya and bacterial oil spot in pomegranate.

Suggested Readings

Blumm, A. 1988. Plant Breeding for Stress Environments. CRC Press, USA.

Bose, T.K., Mitra S.K., Farooqi A.A. and Sadhu, M.K. 1999. Tropical Horticulture. Vol. I. Naya Prokash, Kolkata.

Bose, T.K., Mitra, S.K. and Sanyal, D. (Ed.). 2002. Fruits of India – Tropical and Sub-tropical. 3rd Ed. Vols. I, II. Naya Udyog, Kolkata.

Chadha, K.L. and Pareek, O.P. (Eds.). 1996. Advances in Horticulture. Vol. II to IV. Malhotra Publ. House, New Delhi.

Chadha, K.L. and Rethinam, P. (Eds.). 1993. Advances in Horticulture. Vol. IX. Plantation Crops and Spices. Part-I. Malhotra Publ. House, New Delhi.

Christiansen, M.N. and Lewis, C.F. 1982. Breeding Plants for Less Favourable Environments. Wiley Inter. Science, USA.

Hsiao, T.C. 1973. Plant Responses to Water Stress. Ann. Rev. Plant Physiology 24: 519-570.

Levitt, J. 1972. Response of Plants to Environmental Stresses. Academic Press, USA.

Nakasone, H.Y. and Paull, R.E. 1998. Tropical Fruits. CABI, UK.

Turener, N.C. and Kramer, P.J. 1980. Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons.

FSC 611 BREEDING OF FRUIT CROPS (4L+1P) II

Objective

To educate students about the principles and practices of fruit breeding.

Theory

UNIT I

Importance, problems and prospects in improvement of fruit crops; origin and centres of diversity, Germplasm collection, evaluation and conservation, NAGs of different fruit crops.

UNIT II

Causes of natural genetic variations; breeding systems - incompatibility, apomixis, parthenocarpy, sterility, dichogamy etc., pollinizers.

UNIT III

Methods of crop improvement - Introduction, clonal selection, hybridization, mutation and polyploidy; innovative approaches like embryo rescue, *in vitro* mutagenesis, protoplast fusion, genetic engineering; production of seedless fruits; early evaluation techniques; Breeding objectives and ideotypes, methods of improvement, inheritance of economic traits, breeding for biotic and abiotic stresses and achievements in important fruit crops like mango, banana, citrus, grape, papaya, apple, peach, pear, almond etc.; breeding of rootstocks.

UNIT IV

Use of DNA marker technology and marker-assisted selection in fruit crop breeding.

UNIT V

Varietal registration and patents, Nomenclature and crop descriptors of important fruit crops, norms for release of fruit varieties.

Practicals

Maintenance of breeding block; Nursery raising of hybrid seeds; Hybrid evaluation techniques and preselection criteria; Methods of germplasm introduction and quarantine; Methods of germplasm conservation and exchange; Varietal registration and use of descriptors; Floral biology and hybridization techniques of: a. Citrus b. Mango c. Grape d. Papaya; Pollen collection, viability and storage; Mutation through irradiation; Use of chemical mutations; Embryo rescue in fruit crops, use of DNAmarkers.

Suggested Readings

Bhojwani, S.S. and Razdan, M.K. 2006. Plant Tissue Culture -Theory and Practice. Elsevier Publication, Amesterdam.

Chadha, K.L. and Pareek, O.P. 1996. (Eds.). Advances in Horticulture. Vol. I to IV. Malhotra Publ. House, New Delhi.

Chadha, K.L. and Shikhamany, S.D. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House, New Delhi.

Frankel, O.H. and Hawkes, J.G. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.

Janick, J. and Moore, J.N. 1996. Fruit Breeding. Vols. I to III. John Wiley & Sons.

Janick, Jules and Moore, J.N. 1996. Advances in Fruit Breeding, AVI Pub., USA.

Kumar, N. 2006. Breeding of Horticultural Crops - Principles and Practices. New India Publishing Agency, New Delhi.

Moore, J.N. and Janick, Jules. 1996. Methods in Fruit Breeding. Purdue University Press, South Campus Court D., USA

Parthasarathy, V.A., Bose, T.K., Deka, P.C., Das, P., Mitra, S.K. and Mohanadas, S. 2001. Biotechnology of Horticultural Crops. Vols. I-III. Naya Prokash, Kolkata.

Ray, P.K. Breeding of Tropical and Sub-tropical Fruits. Narosa Publishing House, New Delhi.

Simmonds, N.W. 1976. Evolution of Crop Plants, Orient Longman, London.

VEGETABLE SCIENCE (VSC)

VSC 501 PRINCIPLES OF VEGETABLE PRODUCTION (4L+1P) I

Objective

To impart knowledge on basic requirements for successful cultivation of vegetable crops.

Theory

UNIT I

Importance of vegetables; area and production in India; types of vegetable growing; classification of vegetables.

UNIT II

Soil and climate factors; heat units and chilling requirements; cultural practices; physiological basis of growth, yield and quality as influenced by environment, chemicals and growth regulators.

UNIT III

Principles governing vegetable production under glass and plastic houses; nutrients essential for plant growth; manures, chemical fertilizers and their response; irrigation and water requirements; crop rotation, crop succession, inter- and mixed-cropping; mulching.

UNIT IV

Insect pests, diseases, physiological disorders and their control measures; role of plant growth substances.

UNIT-V

Harvesting, grading, storage and marketing; vegetable seed production and its storage.

UNIT-VI

Organic vegetable cultivation; vegetable cultivation for higher nutrition, value addition and export.

Practicals

Visit to Divisional Research Farm; Nursery bed preparation of vegetable crops; Field visit to research and seed crop fields of okra, cowpea, dolichos, tomato, cluster beans & cucurbit crops; Field visit to UVRD research farm for cultural operations; Visit to Centre for Protected Cultivation and W.T.C. for understanding various methods of irrigation; Visit to experimental plots for identifying insect pests and diseases of vegetables; Identification of various vegetable seeds and seedlings.

Suggested Readings

Bose, T.K., Som, M.G. and Kabir, J. 2003. Vegetable Crops, Naya Prokash, Kolkata.

Chadha K.L. 2001. Hand Book of Horticulture, ICAR Publication, New Delhi.

Choudhary, B. 1967. Vegetables. 1st edn. National Book Trust, New Delhi.

Decoteau, D. 2000. Vegetable Crops, Prentice Hall, USA.

Kalloo, G. and Chadha, K.L. 1993. Advances in Horticulture- Vegetable Crops (Vol. 5 & 6), Malhotra Pub. House, New Delhi

Rai, N. and Yadav, D.S. 2005. Advances in Vegetable Production. Researchco Book Centre, New Delhi.

Shanmugavelu, K.G. 1989. Production Technology of Vegetable Crops, Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.

Thamburaj, S. and Singh, N. 2003. Text Book of Vegetables, Tuber Crops and Spices, ICAR, New Delhi.

Thind, T.S. and Gupta, S.K. 2006. Disease Problems in Vegetable Crops, Scientific Publishers, New Delhi.

Thomson, H.C. and Kelly, W.C. 1990. Vegetable Crops. 5th edn. McGraw Hill Publishing Co. Ltd., New Delhi.

VSC 502 PRINCIPLES OF VEGETABLE BREEDING (4L+1P) I

Objective

To teach basic principles and practices of vegetable breeding.

Theory

UNIT I

Importance, history and evolutionary aspects of vegetable breeding and its variation from cereal crop breeding; genetic architecture; techniques of selfing and crossing; breeding systems and methods.

UNIT II

Selection procedures and hybridization, Heterosis breeding – basis, facilitating mechanisms like male sterility, self-incompatibility and sex forms; Biotic stress resistance breeding - diseases, insect pests and nematode; abiotic stress resistance breeding –temperature, moisture and salt; Breeding for WUE and NUE; mutation breeding; polyploidy breeding; quality improvement; Improvement of asexually propagated vegetable crops and vegetables suitable for protected environment.

UNIT III

Ideotype breeding; varietal release procedure; DUS testing in vegetable crops; Application of *In vitro* and molecular techniques in vegetable improvement.

UNIT IV

Issues related to intellectual property rights and protection of plant varieties and farmers rights authority; Registration of plant varieties and EDVs.

Practicals

Floral biology and pollination behaviour of different vegetables; Techniques of selfing and crossing of different vegetables, *viz*. okra, cole crops, cucurbits, tomato, brinjal, chilli etc.; Breeding system and handling of filial generations of different vegetables; Exposure to biotechnological lab practices.

Suggested Readings

Allard, R.W. 1960. Principle of Plant Breeding, John Willey and Sons, USA.

Kalloo, G. 1988. Vegetable Breeding (Vol. I, II, III), CRC Press, Fl, USA.

Kole, C.R. 2007. Genome Mapping and Molecular Breeding in Plants- Vegetables, Springer, USA.

Peter, K.V. and Pradeep Kumar, T. 1998. Genetics and Breeding of Vegetables, ICAR, New Delhi.

Prohens, J. and Nuez, F. 2007. Handbook of Plant Breeding- Vegetables (Vol I & II), Springer, USA.

Singh, B.D. 2007. Plant Breeding- Principles and Methods (8th edn.), Kalyani Publishers, New Delhi.

Singh, Ram J. 2007. Genetic Resources, Chromosome Engineering, and Crop Improvement-Vegetable Crops (Vol. 3), CRC Press, Fl, USA.

VSC 511/SST 511 PRINCIPLES AND TECHNIQUES OF VEGETABLE SEED PRODUCTION (4L+1P) II

Objective

To impart knowledge on principles and methods of quality seed and planting material production in vegetable crops.

Theory

UNIT I

Importance and present status of vegetable seed industry; intellectual property rights and their implications; new seed policies; DUS testing principles and procedures; impact of PVP on growth of seed industry.

UNIT II

Genetical and agronomical principles of seed production; categories of seed and their maintenance; seed certification; seed standards; seed act; plant quarantine and quality control.

UNIT III

Seed morphology and development in vegetable seeds; agro-techniques for vegetable seed production; environmental factors related to flowering/bolting in vegetable crops; floral biology; pollination systems and breeding techniques related to vegetable seed production in different crops; isolation distances; roguing; selection procedures and criteria for seed production; hybrid seeds; seed extraction methods; maintenance breeding in vegetable crops.

Practicals

Visit to Experimental farms of divisions of vegetable science, seed science & technology and CPCT; Seed production technology of cucurbits, solanaceous vegetables and cole crops in open, under poly-house & low tunnel; Crossing & emasculation and pollination systems in different vegetable crops. Seed production techniques of cauliflower, peas, French bean, winter bean, *Dolichos* bean, okra, onion, brinjal, chilli, capsicum, carrot, turnip, and radish; Floral biology, determining of planting ratios for hybrid seed production and maintenance of varieties and parental lines.

Suggested Readings

Agarwal, R.L. 1996. Seed Technology. Oxford, IBH Publishing Co., New Delhi.

Basra, A.S. 2000. Hybrid Seed Production in Vegetables. CRC Press, Fl, USA.

Desai, B.B., Katecha, P.M. and Salunke D.K. 1997. Seed Hand Book: Biology, Production, Processing and Storage. Marcel Dekker.

George, Raymond A.T. 1999.Vegetable Seed Production. CABI Publishing, New York.

Kelly A.F. & George R.A.T. (Eds.).1998. Encyclopedia of Seed Production of World Crops. John Wiley & Sons.

Salunkhe, D.K., Desai, B.B. and Bhat, N.R. 1987. Vegetable and Flower Seed Production. Agricole. Publishing Academy, New Delhi.

Singh, S.P. 2001. Seed Production of Commercial Vegetables. Agrotech Publishing Academy, New Delhi.

VSC 512 WINTER VEGETABLES (3L+1P) II

Objective

To impart knowledge on production technology and management of cool season vegetable crops.

Theory

Origin, distribution and botanical relationship; morphology and taxonomy; nutritional and medicinal value; principles in growing of these crops; physiological and environmental factors associated with growth and production; modern concept of nursery; water and weed management; physiological basis of growth; yield and quality as influenced by chemicals and growth regulators; standard varieties and F_1 hybrids, seed production techniques, insect pests, diseases and their control measures; nutrient management; physiological disorders (due to macro- and micro-nutrient deficiencies and environmental factors); pre and post harvest management and value addition.

UNIT I
Potato

UNIT II
Cole crops

UNIT III
Root crops

UNIT IV
Bulb crops

UNIT V
Leafy vegetables, pea, broad bean.

Practicals

Identification of winter vegetables & their Seeds; Nursery management of winter vegetables; Identification of Insect pests, diseases and physiological disorders of winter vegetables; field trials of onion, peas, cole crops and root crops; Cultivation of winter vegetables under different protective structures; Identification and cultivation tips of exotic vegetables; Identification of marketable maturity stages in different winter vegetables and seed production techniques of winter vegetables.

Suggested Readings

Thamburaj, S. and Singh, N. 2003. Text Book of Vegetables, Tuber Crops and Spices, ICAR, New Delhi.

Shanmugavelu, K.G. 1989. Production Technology of Vegetable Crops, Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.

Chadha, K.L. 2001. Hand Book of Horticulture, ICAR Publication, New Delhi.

Kalloo, G. and Chadha, K.L. 1993. Advances in Horticulture- Vegetable Crops (Vols. 5 & 6) Malhotra Pub. House, New Delhi

Bose, T.K., Kabir, J., Maity, T.K., Parthasarathy, V.A. and Som, M.G. 2003. Vegetable Crops (Vol.1 & 2), Naya Prokash, Kolkata.

VSC 513 PRODUCTION OF UNDERUTILIZED AND EXOTIC VEGETABLE CROPS

(2L+1P) II

Objective

To educate students on production technology of underutilized and exotic vegetable crops.

Theory

Importance and scope of growing under utilized and exotic vegetables; origin, distribution, general morphology, taxonomy, climate and soil requirement, production technology, varieties, seed production and management of insect-pests and diseases in underutilized vegetables, namely

UNIT I

Dolichos bean, asparagus bean, cluster bean.

UNIT II

Round melon, spine gourd, long melon, snap melon.

UNIT III

Amaranthus, chenopod, fenugreek, *Solanum torvum*, *Solanum pimpinellifolium*, Husk tomato etc.

UNIT IV

Exotic vegetables, namely, artichoke, asparagus, baby corn, broccoli, Brussels sprout, Chinese cabbage, cherry tomato, celery, endive, leek, lettuce, parsley, parsnip, rhubarb, Swiss chard, gherkin and winter bean.

Practicals

Visit to centre of protected cultivation and UVRD; Different aspects of nursery management and production tips of broccoli, Brussels sprouts, Chinese cabbage; Cultivation practices and tips for seed production and Insect pest and disease management in cherry tomato, gherkin, broccoli, celery, lettuce, parsley, Brussels sprouts, Chinese cabbage, parsnip, winter bean, artichoke, asparagus, leek, endive.

Suggested Readings

Arya, Prem Singh 2000. Spice Crops of India. Kalyani Publishers, New Delhi.

Bose, T.K., Som, M.G. and Kabir, J. 2003. Vegetable Crops, Naya Prokash, Kolkata.

Choudhary, B. 1967. Vegetables, 1st edn. National Book Trust, New Delhi.

Decoteau, D. 2000. Vegetable Crops, Printice Hall, USA.

Sirohi, P.S. and Behera, T.K. 2000. Unusual Exotic Vegetables for Higher Profit. IARI, Publication, New Delhi.

Thamburaj, S. and Singh, N. 2003. Text Book of Vegetables, Tuber Crops and Spices, ICAR, New Delhi.

Thomson, H.C. and Kelly, W.C. 1990. Vegetable Crops. 5th edn. McGraw Hill Publishing Co. Ltd., New Delhi.

Wein, H.C. 2002. The Physiology of Vegetable Crops, CABI, Wallingford.

Williams, J. T. 1993. Underutilized Crops-Pulses and Vegetables. Chapman and Hall, London

VSC 601 Hi-TECH VEGETABLE FARMING (3+1) I

Objective

To keep the students abreast with the latest concepts, developments and trends in hi-tech vegetable farming.

Theory

UNIT I

Modern controlled nursery raising system in vegetable crops; improved hybrid vegetable growing system; safe vegetable growing – IPM, INM.

UNIT II

Precision vegetable cultivation – laser leveling, mechanized direct seed sowing; seedling transplanting, mapping of soils and plant attributes, site specific input application management, weed management, insect pests and disease management, yield mapping.

UNIT III

Efficient water and fertilizer utilization – drip irrigation, sprinklers, low pressure irrigation; management of biotic stress – insect proof net vegetable growing, coloured plastic strip mulching; Good agricultural practices in vegetable crops; organic vegetable cultivation.

UNIT IV

On farm minimal primary processing; packaging; value addition; cool chain transportation and end users marketing system; Remote sensing, GIS and GPS system.

UNIT V

Traceability; Quality and safety standards of vegetables; Hydroponics, aeroponics & grafting in vegetable crops, Quality assessment - electronic sensors; vegetable marketing information system; Industry led vegetable growing - processing, nutraceuticals & food colour extraction.

Practicals

Media preparation, filling of plug-trays, and sowing of seeds in modern controlled nursery; Vegetable grafting, exposure to minimal processing, packaging, remote sensing, GIS and GPS; Visit to vegetable mechanized farms including organic farms and cool chain industry; Determination of chemical residues and nutraceuticals in vegetable produce.

Suggested Readings

Kalloo, G. and Chadha, K.L. 1993. Advances in Horticulture- Vegetable Crops (Vols. 5 & 6) Malhotra Pub. House, New Delhi.

Srinivasan, A. 2006. Handbook of Precision Agriculture: Principles and Applications (Crop Science), CRC Press, USA.

Tiwari, G.N. Greenhouse Technology for Controlled Environment.

Resh Howard, M. 2002. Hydroponic Food Production. CRS Press, USA

Benton Jones, J. Jr. 2004. A Guide for the Hydroponic & Soilless Culture Grower. CRS Press, USA.

Anonymous 1994. Greenhouse Vegetable Production Guide for Commercial Growers. British Columbia Ministry of Agriculture, Fisheries and Food, British Columbia, Canada.

Thompson, A.K. 1996. Post harvest technology of fruit and vegetable. Blackwell Science Ltd. USA.

Rosa L.A. de, Alvarez-Parrilla and Gonzalez-Aguilar, G.A. 2010. Fruit and Vegetable Phytochemicals. Blackwell Publishing, USA.

VSC 521 SUMMER VEGETABLES **(3L+1P) III**

Objective

To impart knowledge on production technology and management of warm season vegetable crops.

Theory

Origin, distribution and botanical relationship; general morphology and taxonomy; nutritional and medicinal value; standard varieties and F_1 hybrids, their evaluation and characteristics; basic principles of production, effect of environmental factors on the growth and yield; nutrient management; seed production, insect pests and diseases and their control measures; physiological disorders (due to macro and micronutrient deficiencies and environmental factors); modern concept of nursery; water and weed management; physiological basis of growth; yield and quality as influenced by chemicals and growth regulators; pre and post harvest management; value addition of summer vegetables.

UNIT I
Solanaceous vegetables.

UNIT II
Okra, peas, beans.

UNIT III
Cucurbitaceous vegetables.

UNIT IV
Green leafy vegetables.

UNIT V
Tapioca, sweet potato.

Practicals

Identification of summer vegetables and their seeds; nursery management of summer vegetables; identification of insect pests, diseases and physiological disorders of summer vegetables; field trials of cowpea, amaranth, ridgegourd and sponge gourd, cucumber, ashgourd, pumpkin, bottlegourd and bittergourd, brinjal, chilli, tomato, okra, cluster bean and sweet potato; Cultivation of summer vegetables under different protective structures; identification of marketable maturity stages in different summer vegetables; seed production techniques of summer vegetables.

Suggested Readings

Bose, T.K., Som, M.G. and Kabir, J. 2003. Vegetable Crops, Naya Prokash, Kolkata.

Choudhary, B. 1967. Vegetables, 1st edn. National Book Trust, New Delhi.

Kalloo, G. and Chadha, K.L. 1993. Advances in Horticulture- Vegetable Crops (Vols. 5 & 6) Malhotra Pub. House, New Delhi.

Shanmugavelu, K.G. 1989. Production Technology of Vegetable Crops, Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.

Thamburaj, S. and Singh, N. 2003. Text Book of Vegetables, Tuber Crops and Spices, ICAR, New Delhi.

Thomson, H.C. and Kelly, W.C. 1990. Vegetable Crops. 5th edn. McGraw Hill Publishing Co. Ltd., New Delhi.

VSC 611 BREEDING OF CROSS-POLLINATED VEGETABLE CROPS (3L+1P) II

Objective

To impart knowledge on improvement of cross-pollinated vegetable crops and keep abreast the students with the latest advances.

Theory

Origin; evolution; history; genetic resources; distribution; cytogenetics; genetics of important traits; breeding objectives and improvement of;

UNIT I

Cole crops – Cauliflower, cabbage, broccoli, knol khol etc.

UNIT II

Cucurbitaceous vegetables – Cucumber, melons, gourds, pumpkin, squash etc.

UNIT III

Bulb crops – Onion, garlic, leek, bunching onion etc.; root vegetables – carrot, radish, turnip, beet

UNIT IV

Leaf vegetables - Amaranth, palak, Chenopod etc.; asparagus, sweet corn and baby corn.

Practicals

Breeding technique and procedures for bulb and root crops, leafy vegetables; Breeding technique and procedures for cole crops and cucurbitaceous vegetables; Use of biotechnological tools and cytogenetics in vegetable breeding.

Suggested Readings

Bassett, M.J. 2001. Breeding Vegetable Crops. AVI Publishing, C.T., USA.

Kalloo, G. 1988. Vegetable Breeding (Vol. I, II, III), CRC Press, Fl, USA.

Nieuwhof, M. 1969. Cole Crops. Leonard Hill, London.

Robinson, R.W. and Dekker-Walter, D.S. 1997. Cucurbits. CABI Publishing, U.K.

Rabinowitch, H.D. and Brewster, J.C. 1990. Onion and their Allies. CABI Publishing, U.K.

VSC 621 BREEDING OF SELF-POLLINATED VEGETABLE CROPS (3L+1P) III

Objective

To impart knowledge on improvement of self-pollinated vegetable crops and the recent advancements.

Theory

Origin; evolution; history; distribution; genetic resources; cytogenetics; genetics of important traits; breeding objectives and improvement of;

UNIT I

Solanaceous vegetable crops - Potato, tomato, brinjal, chilli, sweet pepper.

UNIT II

Leguminous vegetable crops – Garden pea, French bean, cowpea, broad bean, cluster bean, winged bean, lab lab and sword bean.

UNIT III

Okra, lettuce and fenugreek.

Practicals

Breeding techniques and procedures for tomato, capsicum, okra, garden pea; Potato, cowpea, Indian bean, *bakla*, bean etc.; brinjal, French bean, lettuce, fenugreek etc.; Application of biotechnological tools and cytogenetics in breeding of above vegetables.

Suggested Readings

Bassett, M.J. 2001. Breeding Vegetable Crops. AVI Publishing, C.T., USA.

Kalloo, G. 1988. Vegetable Breeding (Vol. I, II, III), CRC Press, Fl, USA.

Kole, C.R. 2007. Genome mapping and molecular breeding in Plants- Vegetables, Springer, USA.

Prohens, J. and Nuez, F. 2007. Handbook of Plant Breeding- Vegetables (Vol I & II), Springer, USA.

Singh, Ram J. 2007. Genetic Resources, Chromosome Engineering, and Crop Improvement-Vegetable Crops (Vol. 3), CRC Press, Fl, USA.

VSC 622 BIOTECHNOLOGY FOR VEGETABLE CROPS IMPROVEMENT (3L+1P) III

Objective

To educate students on application of basic concepts of biotechnology as a tool for improvement of vegetable crops.

Theory

UNIT I

Role and scope of biotechnology and molecular tools in vegetable breeding; *In vitro* culture methods, somaclonal variation, transformation, somatic hybridization, phylogenetic relationships; Androgenesis, meristem, ovary and embryo culture; synthetic seeds; haploidization; instant inbred line development.

UNIT II

Introduction to molecular tools, markers – morphological, isozymes, DNA markers (RFLP, AFLP, RAPD, SSR, SNPs, ESTs etc.; construction of linkage maps; development of mapping populations (F_2, RILs, NILs, back crosses, DH) and their uses; application of markers – finger printing; diversity analysis; tagging of important traits, gene pyramiding, hybrid testing, QTL analysis; marker-assisted breeding for biotic & abiotic stresses, nutraceutical bioactive health compounds; and food colour related improvement in vegetable crops.

UNIT III

Bioinformatics – principles and application; molecular breeding advances in important vegetable crops.

UNIT IV

Recombinant DNA technology, methods of transformation; Transgenic development in vegetable crops –insect pest, fungal bacterial and viral diseases resistance; male sterility, parthenogenesis; post harvest management – shelf-life enhancement; Biosafety issues and regulatory procedures of GMOs and intellectual property rights.

Practicals

Demonstration of the procedure for *in-vitro* culture in few vegetables; Molecular marker analysis including DNA finger printing, diversity analysis and hybridity testing of different vegetable crops; Development of transformation protocol for transgenic.

Suggested Readings

Conger B.V. 1981. Cloning Agricultural Plants via *In-vitro* Techniques. CRC Press, USA.

Galun, E., Breiman, A. and Barton, J. 1997. Imperial College Press, London, UK.

Gamborg, O.L. and Phillips G.C. 1995. Plant Cell, Tissue and Organ Culture. Springer, USA.

Kole, C.R. 2007. Genome Mapping and Molecular Breeding in Plants- Vegetables, Springer, USA.

Paterson, A.H. 1998. Molecular Dissection of Complex Traits. CRC Press, NY, USA.

Singh, B.D. 2006. Plant Biotechnology. Kalyani Publishers, Ludhiana and New Delhi

Singh, Ram J. 2007. Genetic Resources, Chromosome Engineering, and Crop Improvement-Vegetable Crops (Vol. 3), CRC Press, Fl, USA.

Valpuesta V. 2002. Fruit and Vegetable Biotechnology. Woodhead Publishing, Cambridge, UK.

Vienne, D. de. 1998. Molecular Markers in Plant Genetics and Biotechnology. Science Publishers, Inc. Plymoth, UK.

FLORICULTURE AND LANDSCAPE ARCHITECTURE (FLA)

FLA 501 FUNDAMENTALS OF FLORICULTURE (3L+2P) I

Objective

To teach the principles and practices of cultivating ornamental crops and gardens.

Theory

UNIT I

Importance and scope of floriculture; history and development of gardens; garden styles and designs; features of gardens.

UNIT II

Uses and cultivation of ornamental trees, shrubs, climbers, bulbous plants and flowering annuals; cacti and succulents, ferns, palms and foliage plants; greenhouse plants, their uses, cultivation and maintenance; principles of training, pruning, bending, pinching and disbudding.

UNIT III

Turf culture; factors governing growth and flowering of ornamental plants including exploitation of photo-periodism; Principles of soilless culture and protected cultivation.

UNIT IV

Layout and management of nursery of ornamental plants; propagation methods and structures.

UNIT-V

Fundamental of post harvest technology of important flower crops; factors governing the post harvest life of cut flowers; principles like precooling, pulsing, bud opening, storage; flower senescence; physiological disorders; cutting, grading, packaging and marketing of cut flower crops.

Practicals

Identification of important ornamentals; Layout of nursery; Propagation techniques like cutting, budding, layering, grafting; Exposure to cultural practices like pinching, disbudding in loose flower crops; Training, pruning and bending in roses; Post harvest management of cut flowers and loose flowers.

Suggested Readings

Armitage, Allan M. and Laushman, Judy M. 2003. Specialty Cut Flowers. Second Ed. Timber Press.

Bhattacharjee, S.K. and De, L.C. 2003. Advanced Commercial Floriculture, Vol. 1. Aavishkar Publishers & Distributors, Jaipur.

Bhattacharjee, Supriya Kumar. 2006. Vistas in Floriculture, Pointer Publication, New Delhi.

Bose, T.K., Maiti, R.G., Dhua, R.S. and Das, P. 1999. Floriculture and Landscaping. Naya Prokash, Kolkata.

Bose, T.K., Yadav, L.P., Pal, P., Parthasarathy, V.A. and Das, P. 2003. Commercial Flowers. Vol. I and II. Naya Udyog, Kolkata.

Chadha, K.L. and Bhattacharjee, S.K. 1994. Advances in Horticulture, Vol.10. Malhotra Pub. House, New Delhi.

Chadha, K.L. and Choudhary, B.1992. Ornamental Horticulture in India, ICAR, New Delhi.

Laurie, A. and Rees, V.H. 2001. Floriculture – Fundamentals and Practices. Agrobios, Jodhpur.

Randhawa, G.S. and Mukopadhyay, A. 1998. Floriculture in India. Allied Publishers Limited, New Delhi.

FLA 502 LANDSCAPE GARDENING (3L+2P) I

Objective

To familiarize the students with principles and practices of landscape design and gardening.

Theory

UNIT I

Principles of landscaping and interiorscaping; natural and manmade forms and features; bioaesthetic planning of parks, urban areas, industrial area, golf courses, traffic islands and highways.

UNIT II

Exposure to CAD, developing computer aided designs (CAD); analysis of various types of sites and their landscape treatments; history of gardens in India; types and styles of gardens.

UNIT III

Organization of spaces; visual aspects of plan arrangement namely, view, vista and axis; analysis of problems and application of landscape principles for various types of houses; - landscape principles for educational institutions, religious places, industrial sites, country sides; landscaping of terrace and roof gardens and multistory buildings.

UNIT IV

Landscape principles for farm complexes, embassies, hotels and other buildings, for tourist complexes, picnic spots, camping grounds and archaeological as well as other monuments; landscaping of various categories of roads; master-plans of cities in relation to open spaces, parks and other recreational areas. Eco-tourism, theme parks, xeriscaping and waterscaping.

Practicals

Identification of landscape flowering/foliage plants, shrubs, hedges/edges, climbers/creepers and annuals and perennials: their description; Visit of School of Planning and Architecture; Estimate preparation of Horticulture Development as per DSR; Landscaping of five star hotels: Visit to Delhi Golf Course, Golf Link; Visit to Japanese park for identification and study of landscape features; Layout planning and designing of various types of formal/informal, Japanese gardens, water gardens, roundabout; Layout designing for public parks, hospitals, educational institutions and religious places, Layout designing for Hill gardens.; Propagation and management of landscape planting material. Designing of home garden, rock garden and lily pool garden; Planning and designing for interiorscaping.

Suggested Readings

Bhattacharjee, S.K. 2004. Landscape Gardening and Design with plants. Aavishkar Publishers and Distributers, Jaipur.

Bhattacharjee, S.K. 2004. Landscape Gardening and Design with Plants. Aavishkar Publishers and Distributors, Jaipur, India.

Bhattacharjee, S.K. 2006. Advances in ornamental horticulture (Vol. 5), Pointer Publisher, Jaipur, India.

Bose, T.K., Chowdhury, B. and Sharma, S.P. 2001. Tropical Garden plants in colour. Horticulture and Allied Publishers, Kolkata.

Ervin, S. and Hasbrouck, H. 2001. Landscape modeling: Digital Techniques for Landscape Visualization, McGraw-Hill, New York.

Khullar, Rupinder. 2006. Flowering Trees, Shrubs and Climbers of India, Pakistan, Srilanka, Bhutan and Nepal. Timeless Books, New Delhi.

Nambisan, K.M.P. 1992. Design Elements of Landscape Gardening. Oxford and IBH Publishing Co, New Delhi.

Randhawa, G.S. and Mukopadhyay, A. 1998. Floriculture in India. Allied Publishers Limited, New Delhi.

Root James, B., 1985. Fundamentals of Landscaping and Site Planning, The AVI, Publishing company, Inc., Connecticut, USA.

Sabina, G.T. and Peter, K.V. 2008. Ornamental Plants for Gardens. New India Publ. Agency, New Delhi.

Tickoo, A. 2004. Auto CAD Problem Solving Approach, ISBN 1-4018-51339

FLA 503 SPECIALTY FLOWERS AND CUT GREENS (2L+1P) I

Objective

To impart the knowledge on importance and cultivation of specialty cut flower and cut green crops.

Theory

UNIT I
Introduction, present status, scope importance and avenues for specialty flowers.

UNIT II
Role in diversification.

UNIT III
Cultivation of specialty like Heliconia, red ginger, Bird of Paradise, Ornamental banana, ornamental curcuma, gingers, wax flower, kangaroo paw limonium, lupins, gypsophila, rice flower, solidago etc.

UNIT IV
Cultivation of cut greens like anthurium, ferns, asperagus, cycas palm, thuja, golden bottle brush, ornamental palms, zanado, dracena,eucalyptus etc.

UNIT-V
Post harvest management, quality standards, packing, packaging and marketing trends of cut flowers and cut greens.

Practicals

Identification of specialty cut flowers and cut greens; Media and bed preparation for cultivation; Propagation; Integrated disease and pest management; Post harvest handling of specialty cut flowers and cut greens.

Suggested Readings

Armitage, Allan, M. and Laushman, Judy M. 2003. Specialty Cut Flowers. Second Ed. Timber Press.

Bhattacharjee, S.K. and De, L.C. 2003. Advanced Commercial Floriculture Vol. 1. Aavishkar Publishers & Distributors, Jaipur.

Bhattacharjee, Supriya Kumar. 2006. Vistas in Floriculture. Pointer Publication, New Delhi

Bose, T.K., Yadav, L.P., Pal, P., Parthasarathy, V.A. and Das, P. 2003. Commercial Flowers. Vol. I and II. Naya Udyog, Kolkata.

Salunkhe, K., Bhatt, N.R. and Desai, B.B. 2004. Postharvest Biotechnology of Flowers and Ornamental Plants. Naya Prokash, Kolkata.

FLA 511 BREEDING OF ORNAMENTAL PLANTS (3L+1P) II

Objective

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

Theory

UNIT I

Origin, evolution and distribution of ornamentals; genetic resources and conservation of ornamentals; floral and pollen biology, cytology and cyto-genetics of important flower crops; role of introduction and selection in domestication of wild plants.

UNIT II

Breeding systems; methods of breeding suited to seed and vegetatively propagated plants; role of polyploidy and mutations in the evolution of new varieties; role of heterosis and its exploitation.

UNIT III

Production of F_1 hybrids; utilization of male sterility and self incompatibility; breeding for biotic and abiotic stresses; - inheritance of quantitative and qualitative traits; variation in flower characters like fragrance, flower forms (doubleness) and colour.

UNIT IV

Genetic improvement; breeding objectives and constraints in crops like roses, chrysanthemum, gladiolus, carnation, orchids, anthurium, tuberose, gerbera, heliconia, aster, crossandra, jasmine, marigold, petunia, antirrhinum, gypsophila, cosmos, pansy, phlox, stocks, zinnia, sweet pea, dahlia, lilies, amaryllis, bougainvillea, hibiscus *etc*.

Practicals

Floral and pollen biology of important flower crops; Methods of breeding suited to seed propagated plants; Polyploidy and mutations to evolve new varieties; breeding methods for biotic and abiotic stresses; Male sterility and self incompatibility studies in flower crops; Heterosis and its exploitation in flower crops like marigold; Breeding for characters like fragrance, flower forms (doubleness) and colour.

Suggested Readings

Allard, Robert. W. 1999. Principles of Plant Breeding. John Wiley & Sons. INC. New York.

Alexander Vainstein.2002. Breeding for ornamentals: Classical and Molecular Approaches. Kluwer Academic Publishers, London.

Bhattacharjee, S.K. and De, L.C. 2003. Advanced Commercial Floriculture Vol. 1. Aavishkar Publishers & Distributors, Jaipur.

Bose, T.K. and Yadav, L. P. 2003. Commercial Flowers. Naya Prokash Publishers, Kolkata.

Chadha, K.L. and Bhattacharjee, S.K. Advances in Horticulture Vol. 12, Malhotra Publishing House, New Delhi.

Mc Donald, M.B. and Kwong, F.Y. 2005. Flower Seeds Biology and Technology, CABI Publishing, Oxfordshire, UK.

Watts, Lesie.1980. Flower and Vegetable Plant Breeding. Grower Books.

FLA 521/SST 521 PLANTING MATERIAL AND SEED PRODUCTION IN FLOWER CROPS (2L+1P) III

Objective

To impart basic knowledge about the importance of planting material and production of seed in important flower crops grown in India.

Theory

UNIT I

Scope and importance of planting material in flower crops;

UNIT II

Global and Indian scenario in planting material and flower seed production. Propagation techniques and nursery management.

UNIT III

Propagation structures, sanitary and phyto-sanitary issues, plug plant production, nursery standards,

Hi-tech nurseries, micropropagation of ornamental plants.

UNIT IV

F_1 hybrid seed production advantages, steps involved in hybrid seed production, methods in production of F_1 hybrids in different flowers like marigold, petunia, antirrhinum, zinnia, pansy, lupin, calendula, phlox, vinca, dianthus, sunflower, annual chrysanthemum etc., pollination behaviour and isolation, pollination management.

UNIT-V

Use of incompatibility, use of male sterility, maintenance of variety and seed production in open-pollinated crops.

Practicals

Demonstration of propagation techniques; Nursery management techniques; Plug plant production; Steps involved in hybrid seed production; Hybrid seed production in different flower crops like marigold, petunia, antirrhinum, zinnia, pansy, lupin, calendula, phlox, vinca, dianthus, sunflower, annual chrysanthemum etc

Suggested Readings

Bhattacharjee S.K. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publishers, Jaipur.

Bose, T.K., Yadav, L.P., Pal, P., Parthasarathy, V.A. and Das, P. 2003. Commercial Flowers. Vol. I and II. Naya Udyog, Kolkata.

Hartmann, H.T., Kester, D.E., Davies, F.T. and Geneve, R.L. 2002. Hartmann and Kesters's Plant Propagation: Principles and Practices, 7th edn. Prentice Hall of India, New Delhi.

Larson, R.A. 1992. Introduction of Floriculture. International Book Distributing Co., Lucknow.

FLA 522 INDOOR PLANTS (3L+1P) III

Objective

To educate the students about the importance, management and cultural practices of indoor potted plants grown in India.

Theory

UNIT I

Introduction, importance and use of potted plants; environmental factors affecting growth of indoor plants like light, temperature, humidity and air; watering; plant care and maintenance.

UNIT II

Properties of soil in relation to foliage plants; growing media, substrates: potting media; containers, nutrition and fertilization; description of important flowering and foliage indoor plants.

UNIT III

Cacti and succulents; propagation of indoor plants; plug and pot plant production; diseases and insect-pests of indoor plants; growth regulation in indoor plants.

UNIT IV

Interiorscaping-principles and factors; flower arrangement with fresh and dry flowers; special gardens like dish, terrarium, hanging baskets, window boxes, miniature gardens, vertical garden *etc.*

Practicals

Identification of indoor plants; propagation of indoor plants; growth regulation in indoor plants; Plug and pot plant production; Potting and repotting of plants; Flower arrangement with fresh and dry flowers; special gardens like dish, terrarium, handing baskets, window boxes.

Suggested Readings

Allen, Oliver E. 1982. Decorating with Plants. Time Life Books, Alexandria, Virginia.

Anon. 1979. Reader's Digest Success with House Plants. The Reader's Digest Association, Inc. Pleasantvilli, New York / Montreal.

John Edmond.1980. Container Plant Manual. Grower Books London

Peter Mc Hoy. 1997. The A-Z Guide to House Plants, Marshall Cavendish Publishers, Italy.

Singh, Kanwar P., Raju, D.V.S., Swaroop, K. and Singh, K.P. 2008. Practical Manual on Indoor Plants. Division of Floriculture and Landscaping, IARI, New Delhi.

Trivedi, P.P. 1983. Home Gardening. Statesman Press, New Delhi.

Underwood Crockett, James.1984. Flowering House Plants. Time Life Books, Amsterdam.

William Davidson, 1989, Successful Indoor gardening – Exotic Flowering House Plants, Salamander Book, London / New York.

FLA 611 COMMERCIAL FLORICULTURE (3L+1P) II

Objective

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

Theory

UNIT I

Scope and importance of commercial floriculture in India; production technology including integrated nutrient, water, weed, insect pests and disease management of ornamental plants like rose, marigold, chrysanthemum.

UNIT II

Production technology of orchid, carnation; gerbera, gladiolus, jasmine, dahlia, tuberose, China aster and crossandra under open field conditions for domestic markets; production technology of non traditional flowers; commercial seed production in open field conditions.

UNIT III

Post harvest technology of loose and cut flowers; value addition in flower crops including dry flowers, essential oils, pigments *etc.* Flower forcing and year round flowering through physiological interventions, chemical regulation and environmental manipulation.

Practicals

Post harvest technology of loose and cut flowers; Dry flower making; Extracting of essential oils, pigments; Flower forcing; year round flowering through physiological interventions, chemical regulation and environmental manipulation.

Suggested Readings

Bhattacharjee, S.K. 2006. Advances in Ornamental Horticulture, Vol 1-6, Allied Publishers, Jaipur.

Bose, T.K. and Bhattacharjee, S.K. 1980. Orchids of India. Naya Prokash, Kolkata.

Bose, T.K. and Yadav, L.P. (Eds.) 1989. Commercial Floriculture, Naya Prokash, Kolkata.

Bose, T.K. and Yadav, L.P. 2003. Commercial Flowers, Vol.1, Naya Prokash, Kolkata.

Chadha, K.L. 1985. Ornamental Horticulture. ICAR, Publication, New Delhi.

Kher, M.A. 1975. Chrysanthemum. Dutta Publishers, New Delhi.

Larson, R.A.1980. Introduction to Floriculture. Academic Press, New York.

Swarup, Vishnu 1997. Ornamental Horticulture. Macmillan, New Delhi.

FLA 621 ADVANCED BREEDING OF ORNAMENTAL CROPS (3L+1P) III

Objective

To teach students about the recent research trends in the field of breeding of flower crops with special emphasis on crops grown in India.

Theory

UNIT I

Role of biotechnology in improvement of flower crops; *in vitro* mutagenesis, embryo culture, somaclonal variation, transformation, somatic hybridization, anther and ovule culture including somatic embryogenesis.

UNIT II

Marker assisted selection; molecular characterization; construction of c-DNA library; breeding for biotic and abiotic stresses using biotechnological means; IPR and DUS testing for floricultural crops.

UNIT III

Biosynthetic pathways of pigment, fragrances and senescence flower form; chemistry and importance of secondary metabolites in rose, jasmine, marigold, tuberose, carnation, orchids, lilium and bougainvillea.

UNIT IV

Bioinformatics-principles and applications; advances in important ornamental crops through biotechnology; bio-safety of transgenics.

Practicals

In vitro mutagenesis, embryo culture, somaclonal variation and somatic hybridization, anther and ovule culture and somatic embryogenesis; Genetic transformation, marker assisted selection; IPR and DUS testing for floricultural crops; Construction of c-DNA library; Bioinformatics.

Suggested Readings

Arthur, M. Lesk. 2002. Introduction to Bioinformatics. Oxford University Press, U.K.

Chadha, K.L. and Choudhury, B. 1992. Ornamental Horticulture in India. ICAR, New Delhi.

Neil O., Anderson. 2007. Flower Breeding and Genetics Issues, Challenges and Opportunities for the 21st Century. Springer Publisher, The Netherlands.

Nelson, David L. and Michael, M. Cox. 2000. Principles of Biochemistry. Fourth Edition. Lehninger Publishers.

Panopoulas, N.J. (Ed.). 1981. Genetic Engineering in Plant Sciences. Praeger Publ.

Parthasarathy, V.A., Bose, T.K., Deka, P.C., Das, P., Mitra, S.K. and Mohanadas, S. 2001. Biotechnology of Horticultural Crops. Vol. I-III. Naya Prokash, Kolkata.

Pierik, R.L.M. 1987. In vitro Culture of Higher Plants. Martinus Nijhoff Publ. Amsterdam.

Srivastava, P.S. Narula, Alka and Srivastava, Sheela. 2005. Plant Biotechnology and Molecular Markers. Kluwer Academic Publishers New York, Anamaya Publishers, New Delhi.

FLA 622/PHT 622 VALUE ADDITION IN ORNAMENTAL CROPS (1L+1P) III

Objective

To acquaint the student about the scope and ways of value addition in ornamental crops.

Theory

UNIT I

Importance, opportunities and prospects of value addition in floriculture; national and global scenario. production and exports, supply chain management.

UNIT II

Dry flower making including pot pourries, their uses and trade; extraction technology, uses, sources and trade in essential oils; aromatherapy; pigment and natural dyes extraction technology, sources, uses and trade.

UNIT III

Pharmaceutical and neutraceutical compounds from flower crops; petal embedded hand made paper making and uses, preparation of products like *gulkand*, rose water, *gulroghan*, *attar*, *pankhuri*.

UNIT IV

Floral craft including bouquets, garlands, flower arrangements *etc.* tinting (artificial colouring) of flower crops; Women empowerment through value added products making.

Practicals

Dry flower making including pot pourries; extraction technology, uses, sources and trade in essential oils; Pigment and natural dyes extraction technology; pharmaceutical and neutraceutical compounds from flower crops; preparation of products like *gulkand*, rose water, *gulroghan, attar, pankhuri*; Petal embedded handmade paper making, floral craft including bouquets, garlands, flower arrangements *etc.;* tinting (artificial colouring) of flower crops.

Suggested Readings

Bhattacharjee, S.K. and De, L.C. 2004. Advances in Ornamental Horticulture Vol. V, Pointer publishers, Jaipur.

Lauria, A. and Victor, H.R. 2001. Floriculture – Fundamentals and Practices. Agrobios, Jodhpur.

Lesniewicz, Paul. 1994. Bonsai in your home. Sterling publishing Co, New York.

McDaniel Gary L., 1989. Floral design and arrangement. A Reston Book. Prentice Hall. New Jersey.

Prasad, S. and Kumar, U. 2003. Commercial Floriculture. Agrobios, Jodhpur.

Randhawa, G.S. and Mukhopadhyay, A. 2000. Floriculture in India, Allied publishers, India.

Reddy, S, Janakiram, T., Balaji, T., Kulkarni, S. and Misra, R.L. 2007. Hi-tech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.

Salunkhe, K., Bhatt, N.R. and Desai, B.B. 2004. Postharvest biotechnology of flowers and ornamental plants. Naya Prakash, Kolkata.