Course Curriculum

Master's and Ph.D. Programme
(As per Fifth Deans' Committee recommendation report of ICAR)

COLLEGE OF HORTICULTURE

Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (UP)

Patron

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EXECUTIVE SUMMARY

M.Sc. and Ph.D. programmes are envisaged in three departments viz, Fruit Science, Vegetable Science and Floriculture and Land Scape Architecture.

Fruit Science

- Thrust on advances in management of fruit crops
- Biotechnology, biodiversity conservation, organic production and GAP in fruit cultivation are included
- Faculty should be trained in advance and frontier aspects of biotechnology and post harvest technology.

Vegetable Science

- Thrust on crop improvement and management of vegetable crops grown in India
- Precision farming, biotechnology, organic production and GAP in vegetable cultivation are included.
- Faculty should be trained in advance aspects of biotechnology and post harvest technology of vegetable crops.

Floriculture and Land Scape Architecture

- Thrust on high tech. floriculture, protected cultivation and advances in management of major flower crops grown in India
- Turfing and turf management and CAD are included.
- Faculty should be trained in advance aspects of biotechnology and operation of CAD.

Expected Output

- Revamping of post graduate programme in whole of Horticultural Science throughout the country.
- Imparting quality education.
- Development of technical manpower to cater the need of government, corporate, quasi government and research organizations both in India and abroad in horticulture.
- Exposure to the faculty in the latest technical knowhow.
- Vital step to sustain the Golden Revolution in India.

PREAMBLE

Horticulture plays a pivotal role in the food and livelihood security of India. Though horticultural crops occupy only 8.5% of arable land, they contribute 24.5% of the GDP in agriculture. Plantation crops (tea, coffee and rubber) occupying 0.95% of cropped area have stake of 15.1% of the total export earnings. Economists view that commercialization of agriculture and promotion of agri- business in India is correlated to the progress in the plantation and horticulture sectors. Horticulture and Plantation sector cover production, post-harvest management, marketing, processing and export of fruits, vegetables, flowers, medicinal and aromatic plants, plantation crops, spices, bamboo, mushroom, apiculture and sericulture. On the total production side, India leads the whole world in fruits and vegetables next to China. India has the potential to be the horticulture heaven and plantation paradise.

The performance in production is laudable, but in value addition, processing and export segments, India's contribution is not as expected. In spite of having a 10% share in global production of both fruits and vegetables, just 1.8% is processed and our export is a meager 0.4%. The 10^{th} Five Year Plan envisaged growth rate of 8% in Horticulture. The 11^{th} Plan initiated a massive National Horticulture Mission with an outlay of Rs. 20,000 crores. The existing single M. Sc. (Hort) programme is quite inadequate to meet the present and envisaged human resource requirement. The programme needs to be enlarged as done in the Syllabus of Horticulture in Agricultural Scientists Recruitment Board Examinations. The envisaged M. Sc. programmes are:

1. M. Sc. (Hort) - Fruit Science
2. M. Sc. (Hort) - Vegetable Science
3. M. Sc. (Hort) - Floriculture and Land Scape Architecture

The syllabus in the existing single PG degree programme was expanded to meet the requirements of the four PG Programmes. The basic philosophy of revision envisaged the following:

1. Increasing the basic science content
2. Updating the overall content in view of globalised economy
3. Imbibing technologies from developed countries
4. Compliance to National and International Law in respect of food quality, standards and specifications
5. Use of ICT in Horticulture Education
6. Updating Literature

Brief justifications for each PG Programme are given below:

Fruit Science

M. Sc. and Ph. D. syllabi in fruit science were drafted. Core and optional courses for fruits and plantation crops were included in the syllabi. Production technology, canopy management, propagation and nursery management, and breeding of these crops are covered under core courses. Advances in biotechnology and protected cultivation also find a place in the M. Sc. syllabi. Biodiversity and conservation of perennial crops, IPR issues, GI and IPR, patenting, organic crop production and GAP are included in the syllabus. Advanced aspects in production and breeding of fruits are included in the Ph. D. syllabus. Genomics and biotic and abiotic stress management of Horticultural crops are also included in the Ph. D. syllabus. Reference section is enriched with the latest text books on the concerned subjects.

Vegetable Science

Vegetables form a major component of Indian dietary. They play a major role in nutritional security and save considarable expenses on medicine. A seperate M. Sc. Programme is suggested.

M. Sc. and Ph. D. syllabi in Vegetable Science were. Core and optional courses for vegetable crops were included in the syllabi after thorough discussion. Production technology, breeding and seed production of crops are covered under core courses. Recent advances in biotechnology and protected cultivation also find a place in the PG syllabi. IPR issues, patenting, organic crop production and GAP are included in the syllabus. Production technology of underexploited crops and abiotic stress management are considered as relevant topics for PG curriculum. Reference section is enriched with the latest text books on the concerned subjects.

Floriculture and Landscape Architecture

Floriculture is the aesthetic branch of horticulture which deals with the cultivation of both traditional and commercial flower crops, either in open field or under protected conditions and growing of ornamentals including potted plants and their marketing. Floriculture is an emerging Industry. A seperate M. Sc. programme is hence suggested. M. Sc. and Ph. D. syllabi in Floriculture were drafted. Production technology of cut flowers and loose flowers were included in core courses for M. Sc. programme. Protected Floriculture, turfing and turf management, value addition of flowers and utilization of software CAD for outdoor and indoor landscaping are added as optional courses. Advanced aspects in production, breeding and protected cultivation of flower crops are included in the Ph. D.

syllabus. Advances in landscape architecture are included as optional courses for the Ph. D. syllabus. Reference section is enriched with the latest text books on the concerned subjects.

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ORGANIZATION OF COURSE CONTENTS

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CREDIT REQUIREMENTS

Code Numbers

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

Course Contents

The contents of each course have been organized into:

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

Minimum Credit Requirements

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

Major subject: The subject (department) in which the students takes admission
Minor subject: The subject closely related to students major subject (e.g., if the major subject is Entomology, the appropriate minor subjects should be Plant Pathology & Nematology).
Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.
Non-Credit Compulsory Courses: Please see the relevant section for details. Six courses (PGS 501-PGS 506) are of general nature and are compulsory for Master's programme. Ph. D. students may be exempted from these courses if already studied during Master's degree.

FRUIT SCIENCE

Course Structure – at a Glance

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

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

Department of Fruit Science
Semester wise major courses
Master's Programme

Semester- I				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	**Page No**
1	FSC 501	Tropical and Dry land Fruit Production	3(2+1)	
2	FSC 502	Subtropical and Temperate Fruit Production	3(2+1)	
3	FSC 503	Biodiversity and Conservation of Fruit Crops	3(2+1)	
4	FSC 504	Canopy management in fruit crops	2(1+1)	
5	FSC-599	Master's Research	06	
Total			**17**	
Semester- II				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FSC 505	Propagation and nursery management for fruit crops	3(2+1)	
2	FSC 506	Breeding of fruit crops	3(2+1)	
3	FSC 507	Post harvest technology for fruit crops	3(2+1)	
4	FSC 508	Growth and development of horticultural crops	3(2+1)	
5	FSC-599	Master's Research	04	
Minor				
As Required by thesis problem				
Basic Supporting Course				
6	MCA-501	Computer Fundamentals and Programming	3 (2+1)	
Non Credit course				
7	PGS-502	Technical Writing and Communication Skills	1 (0+1)	
		Total		
Semester- III				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FSC 509	Biotechnology of Horticultural Crops	2+1	
2	FSC 510	Organic Horticulture	1+1	
3	FSC 511	Protected Cultivation	2+1	
4	FSC-599	Master's Research	05	
Minor				
As Required by thesis problem				
Basic Supporting Course				
5	STAT-512	Experimental Design	3 (2+1)	
6	BPS-661	Experimental Statistics	3 (2+1)	
7	BIOCHEM-501	Basic Biochemistry	4(3+1)	
Non Credit Courses				
8	PGS-501	Library and Information Services	1(0+1)	
9	PGS-503	Intellectual Property and Its Management in Agriculture	1(1+0)	
10	PGS-504	Basic concepts in Laboratory Techniques	1 (0+1)	
11	PGS-505	Agriculture Research, Research Ethics and Rural Development Programme	1(1+0)	
12	PGS-506	Disaster Management	1(1+0)	
Total				

Semester- IV				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FSC 512	Gap for Horticultural Crops	1(1+0)	
2	FSC 513	Climate Management in Horticultural Production	1(1+0)	
3	FSC 591	Master's Seminar	1(1+0)	
4	FSC-599	Master's Research	05	
Basic Supporting Course				
5	STAT-511	Statistical Methods for Applied Science	2(1+1)	
Total				

Department of Fruit Science
Semester wise Major courses
Ph.D. Programme

Semester- I				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	**Page No**
1	FSC 601	Advances in Breeding Of Fruit Crops	3 (2+1)	
2	FSC 602	Advances in Production Of Fruit Crops	3 (2+1)	
3	FSC 603	Advances Growth Regulation of Fruit Crops	3 (2+1)	
4	FSC-699	Doctoral Research	05	
Basic Supporting Course				
5	STAT-512	Experimental Design	3 (2+1)	
6	BPS-661	Experimental Statistics	3 (2+1)	
Total				
Semester- II				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FSC 604	Genomics and Bioinformatics in Horticulture	3 (2+1)	
2	FSC 605	Biotic and Abiotic Stress Management in Horticultural Crops	3 (2+1)	
3	FSC-699	Doctoral Research	05	
Minor				
As Required by thesis problem				
Basic Supporting Course				
4	MCA-501	Computer Fundamentals and Programming	3 (2+1)	
Total				
Semester- III				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FSC-699	Doctoral Research	05	
Minor				
As Required by thesis problem				
Total				
Semester- IV				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FSC-691	Doctoral Seminar I	1(1+0)	
2	FSC-692	Doctoral Seminar II	1(1+0)	
3	FSC-699	Doctoral Research	10	
Basic Supporting Course				
4	STAT-511	Statistical Methods for Applied Science	2(1+1)	
Total				
Semester- V				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FSC-699	Doctoral Research	10	
Total			**10**	

Semester- VI				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FSC-699	Doctoral Research	10	
Total			**10**	

FRUIT SCIENCE

Course Contents

FSC 501 TROPICAL AND DRY LAND FRUIT PRODUCTION 3 (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 and Subtropical. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). Advances in Horticulture. Vols. II- IV. 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.

FSC 502 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 3 (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, hazelnut
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. Jagmander Book Agency.

FSC 503 BIODIVERSITY AND CONSERVATION OF FRUIT CROPS 3 (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.

FSC 504 CANOPY MANAGEMENT IN FRUIT CROPS 2 (1+1)

Objective

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

Theory

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

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

types of tree canopies.

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Chadha KL & Shikhamany SD. 1999. The Grape, Improvement, Production and Post Harvest Management. Malhotra Publ. House.
- Pradeep Kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008.Management of Horticultural Crops. New India Publ. Agency.

FSC 505 PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS 3 (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 Prakash.
- Peter KV. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency. Singh SP. 1989 Mist Propagation. Metropolitan Book Co.
- Rajan S & Baby LM. 2007. Propagation of Horticultural Crops. New India Publ. Agency.
- Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.

FSC 506 BREEDING OF FRUIT CROPS 3 (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, polyploid 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 & Sanyol D. (Eds.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra

Publ. House.
- ❖ Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.
- ❖ Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.
- ❖ Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- ❖ Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. Advances in Citriculture. Jagmander Book Agency.

FSC 507 POST HARVEST TECHNOLOGY FOR FRUIT CROPS 3(2+1)

Objective

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

Theory

UNIT I

Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, and 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- ventilated, refrigerated, MAS, CA storage, physical injuries and disorders.

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- ❖ Bhutani RC. 2003. *Fruit and Vegetable Preservation*. Biotech Books. Chadha KL & Pareek OP. (Eds.). 1996 *Advances in Horticulture*. Vol. IV. Malhotra Publ. House.
- ❖ Haid NF & Salunkhe SK. 1997. Post Harvest Physiology and Handling of Fruits and Vegetables. Grenada Publ.
- ❖ Mitra SK. 1997.*Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits*. CABI.
- ❖ Ranganna S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.

- Sudheer KP & Indira V. 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.
- Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. *Post Harvest. An i*ntroduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals. CABI.

FSC 508 GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Buchanan B, Gruiessam 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.
- Leoplod AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3rd Ed. Mc

Graw-Hill.
- Peter KV. 2008. (Ed.) *Basics of Horticulture*. New India Publ. Agency.
- Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.
- Salisbury FB & Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

FSC 509 BIOTECHNOLOGY OF HORTICULTURAL CROPS 3 (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.
- 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.

FSC 510 ORGANIC HORTICULTURE 2 (1+1)

Objective

To develop understanding of organic horticulture production system including GAP.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

Features of organic orchards, working out conversion plan, Input analysis- manures, nutrient status assessment of manures, biocomposting, biofertilizers and their application, panchagavya preparation and other

organic nutrients application, methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application, BD preparations and their role, EM technology and products, biological/natural control of pests and diseases, soil solarization, frame work for GAP, case studies, HACCP analysis, residue analysis in organic products, documentation for certification, visit to fields cultivated under organic practices

Suggested Readings

- Claude A, Vandana S, Sultan I, Vijaya L, Korah M & Bernard D. 2000.
- *The Organic Farming Reader*. Other Indian Press, Goa.
- Gaur AC, Neblakantan S & Dargan KS. 1984 *Organic Manures*. ICAR.
- Lampkin N & Ipswich. 1990. *Organic Farming*. Farming Press. London.
- Lampkin NH & Padel S. 1992. *The Economics of Organic Farming – An International Perspective.* CABI.
- Palaniappan & Annadurai. 2008. *Organic Farming- Theory and Practise*. Scientific Publ.
- Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency. New Delhi.
- Rao S. 1977. *Soil Microorganism and Plant Growth*. Oxford & IBH.

FSC 511 PROTECTED FRUIT CULTURE 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

Interaction of light, temperature, humidity, CO_2, water on crop regulation - Greenhouse heating, cooling, ventilation and shading.

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Aldrich RA & Bartok JW. 1994. *Green House Engineering*. NRAES, Riley, Robb

Hall, Cornell University, Ithaca, New York.
- Bhatcharjee BS. 1959. Rose Growing in Tropics. Thackarspink & Co.
- Laurie A, Kiplingr DD & Nelson KS. 1968. Commercial Flower Forcing. McGraw-Hill.
- Mears DR, Kim MK & Roberts WJ. 1971. Structural Analysis at an Experimental Cable-supported Air Inflated Green Houses. Trans. ASAE.
- Pant V Nelson. 1991. Green House Operation and Management. Bali Publ.
- Pradeep Kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2007. Management of Horticultural Crops. Parts I, II. New India Publ. Agency.

FSC 512 GAP FOR HORTICULTURAL CROPS 1 (1+0)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Suggested Readings

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

FSC 513 CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION 1 (1+0)

Objective

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

Theory

UNIT I

Introduction to climate change. Factors directly connected to climate change, average temperature, change in rainfall amount and patterns, rising atmospheric concentrations of

CO_2, pollution levels such as tropospheric ozone, change in climatic variability and extreme events like receding of glaciers in Himalayas.

UNIT II

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

UNIT III

Impact of climate changes on invasive insect, disease, weed, pests, horticulture yield, quality and sustainability, climate management in field production – mulching - use of plastic-windbreak- spectral changes- frost protection. Climate management in greenhouse- heating - vents - CO_2 injection - screens - artificial light.

UNIT IV

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

Suggested Readings

- Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency.
- Rao GSLHV, Rao GGSN, Rao VUM & Ramakrishnan YS. 2008. *Climate Change and Agriculture over India*. ICAR.
- Rao GSLHV. 2008. *Agricultural Meteorology*. Prentice Hall.

FSC 601 ADVANCES IN BREEDING OF FRUIT CROPS 3 (2+1)

Objective

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

Theory

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

Crops

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

Practical

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

Suggested Readings

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

FSC 602 ADVANCES IN PRODUCTION OF FRUIT CROPS 3 (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. II- IV. 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.

FSC 603 ADVANCES IN GROWTH REGULATION OF FRUIT CROPS 3 (2+1)

Objective

Appraisal on the advances in growth regulation of fruit crops.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Buchanan B, Gruiessam 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.

- Leoplod AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3rd Ed. McGraw-Hill.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency. Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.
- Salisbury FB & Ross CW. 1992. Plant Physiology. 4th Ed. Wadsworth Publ.

FSC 604 GENOMICS AND BIOINFORMATICS IN HORTICULTURE 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

Practical

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

Suggested Readings

- Attwood TK & Parry Smith DJ. 2006. *Introduction to Bioinformatics*. Pearson Edu.
- Baxevanis AD. 2005. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. 3rd Ed. Wiley.
- Bourne PE & Weissig H. (Eds.). 2004. *Structural Bioinformatics*. John Wiley & Sons.
- Durbin R, Eddy SR, Krogh A & Mitchison G. 1999. *Biological Sequence Analysis: Probabilistic Model of Proteins and Nucleic Acids*. Cambridge Univ. Press.
- Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. Vols. I, II. New India Publ. Agency.
- Kohane IS, Kho A & Butte AJ. 2002. *Microarrays for an Integrative Genomics*. M1T Press.
- Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbour Laboratory Press.

FSC 605 BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS 3 (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 CO_2, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations.

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

RWC, chlorophyll flurosence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and water shed locations.

Suggested Readings

- Blumm A. 1988. *Plant Breeding for Stress Environments*. CRC. Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less Favourable Environments.* Wiley Inter. Science.
- Gupta US. 1990. *Physiological Aspects of Dry Farming*.
- Hsiao TC. 1973. Plant Responses to Water Stress. *Ann. Rev. Plant Physiology* 24: 519-570.
- Kramer PJ. 1980. Drought Stress and the Origin of Adaptation. In: *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.
- Levitt J. 1972. *Response of Plants to Environmental Stresses*. Academic Press.
- Maloo SR. 2003. *Abiotic Stress and Crop Productivity*. Agrotech Publ. Academy.
- Mussell H & Staples R. 1979. *Stress Physiology in Crop Plants*. Wiley Inter. Science.
- Nickell LG. 1983. *Plant Growth Regulating Chemicals*. CRC.
- Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.
- Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.

FRUIT SCIENCE

List of Journals & Magazines

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

Suggested Broad Topics for Master's and Doctoral Research

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

VEGETABLE SCIENCE
Course Structure – at a Glance

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

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

Department of Vegetable Science
Semester wise major courses
Master's Programme

Semester- I				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	**Page No**
1	VSC-501	Production Technology of Warm Season Vegetable Crops	3(2+1)	
2	VSC-502	Production Technology of Cool Season Vegetable Crops	3(2+1)	
3	VSC-503	Breeding of vegetable crops	3(2+1)	
4	VSC-504	Growth and Development of Vegetable Crops	3(2+1)	
5	VSC-599	Master's Research	05	
Total			**17**	
Semester- II				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	VSC 505	Seed Production Technology of Vegetable Crops	3 (2+1)	
2	VSC 506	Systematises of Vegetable Crops	2 (1+1)	
3	VSC 507	Production Technology of Underexploited Vegetable Crops	2(1+1)	
4	VSC-599	Master's Research	05	
Minor				
As Required by thesis problem				
Basic Supporting Course				
7	MCA-501	Computer Fundamentals and Programming	3 (2+1)	
Non Credit course				
8	PGS-502	Technical Writing and Communication Skills	1 (0+1)	
		Total	**20**	
Semester- III				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	VSC 508	Organic Vegetable Production Technology	2 (1+1)	
2	VSC 509	Fundamentals of Processing of Vegetables	2 (1+1)	
3	VSC-599	Master's Research	05	
Minor				
As Required by thesis problem				
Basic Supporting Course				
11	STAT-512	Experimental Design	3 (2+1)	
12	BPS-661	Experimental Statistics	3 (2+1)	
13	BIOCHEM-501	Basic Biochemistry	4(3+1)	
Non Credit Courses				
14	PGS-501	Library and Information Services	1(0+1)	
15	PGS-503	Intellectual Property and Its Management in Agriculture	1(1+0)	
16	PGS-504	Basic concepts in Laboratory Techniques	1 (0+1)	
17	PGS-505	Agriculture Research, Research Ethics and Rural Development Programme	1(1+0)	
18	PGS-506	Disaster Management	1(1+0)	
Total			**43**	

Semester- IV				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	VSC-591	Master's Seminar	1(1+0)	
2	VSC-599	Master's Research	05	
Basic Supporting Course				
3	STAT-511	Statistical Methods for Applied Science	2(1+1)	
Total			**08**	

College of Horticulture
Department of Vegetable Science

Semester wise courses

Ph.D. Programme

Semester- I				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	**Page No**
1	VSC-601	Advances in Vegetable Production	3(2+1)	
2	VSC-602	Advances in Breeding of Vegetable Production	3(2+1)	
3	VSC-603	Protected Cultivation of Vegetable Crops	2(1+1)	
4	VSC-604	Biotechnology of Vegetable Crops	3(2+1)	
5	VSC-699	Doctoral Research	05	
Basic Supporting Course				
6	STAT-512	Experimental Design	3 (2+1)	
7	BPS-661	Experimental Statistics	3 (2+1)	
		Total	**22**	
Semester- II				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	VSC-605	Seed Certification, Processing and Storage of Vegetable Crop	2(1+1)	
2	VSC-699	Doctoral Research	05	
Minor				
As Required by thesis problem				
Basic Supporting Course				
5	MCA-501	Computer Fundamentals and Programming	3 (2+1)	
		Total	**14**	
Semester- III				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	VSC-606	Abiotic Stress Management in Vegetable Crops	3(2+1)	
2	VSC-699	Doctoral Research	05	
Minor				
As Required by thesis problem				
		Total	**27**	
Semester- IV				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	VSC-691	Doctoral Seminar I	1(1+0)	
2	VSC-692	Doctoral Seminar II	1(1+0)	
3	VSC-699	Doctoral Research	10	
Basic Supporting Course				
1	STAT-511	Statistical Methods for Applied Science	2(1+1)	
		Total	**14**	

Semester- V				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	VSC-699	Doctoral Research	10	
Total			**10**	
Semester- VI				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	VSC-699	Doctoral Research	10	
Total			**10**	

VEGETABLE SCIENCE

Course Contents

VSC 501 PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 3 (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.

VSC 502 PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS 3 (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 clusterbean

UNIT III Cucurbitaceous crops

UNIT IV Tapioca and sweet potato

UNIT V Green leafy warm season vegetables

Practical

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

Suggested Readings

- Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.
- Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

- Bose TK, Som MG & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.
- Brown HD & Hutchison CS. *Vegetable Science*. JB Lippincott Co.
- Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture*. Vols. V-X. Malhotra Publ. House.
- Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
- Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons.
- Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
- Edmond JB, Musser AM & Andrews FS. 1964. *Fundamentals of Horticulture*. Blakiston Co
- Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency.
- Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.
- Kalloo 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.
- 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.

VSC 503 BREEDING OF VEGETABLE CROPS 3 (2+1)

Objective

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

Theory

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in

vegetable crops-Issue of patenting, PPVFR act.

UNIT I Potato and tomato

UNIT II Eggplant, hot pepper, sweet pepper and okra

UNIT III Peas and beans, amaranth, chenopods and lettuce

UNIT IV Gourds, melons, pumpkins and squashes

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

Practical

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

Suggested Readings

- Allard RW. 1999. Principles of Plant Breeding. John Wiley & Sons. Basset MJ. (Ed.). 1986. Breeding Vegetable Crops. AVI Publ.
- Dhillon BS, Tyagi RK, Saxena S. & Randhawa GJ. 2005. Plant Genetic Resources: Horticultural Crops. Narosa Publ. House.
- Fageria MS, Arya PS & Choudhary AK. 2000. Vegetable Crops: Breeding and Seed Production. Vol. I. Kalyani.
- Gardner EJ. 1975. Principles of Genetics. John Wiley & Sons.
- Hayes HK, Immer FR & Smith DC. 1955. Methods of Plant Breeding.McGraw-Hill.
- Hayward MD, Bosemark NO & Romagosa I. (Eds.). 1993. Plant Breeding- Principles and Prospects. Chapman & Hall.
- Kalloo G. 1988. Vegetable Breeding. Vols. I-III. CRC Press.
- Kalloo G. 1998. Vegetable Breeding. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
- Kumar JC & Dhaliwal MS. 1990. Techniques of Developing Hybrids in Vegetable Crops. Agro Botanical Publ.
- Paroda RS & Kalloo G. (Eds.). 1995. Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Region. FAO.
- Peter KV & Pradeep Kumar T. 2008. Genetics and Breeding of Vegetables. Revised, ICAR.
- Rai N & Rai M. 2006. Heterosis Breeding in Vegetable Crops. New India Publ. Agency.
- Ram HH. 1998. Vegetable Breeding: Principles and Practices. Kalyani. Simmonds NW. 1978. Principles of Crop Improvement. Longman.
- Singh BD. 1983. Plant Breeding. Kalyani.
- Singh PK, Dasgupta SK & Tripathi SK. 2004. Hybrid Vegetable Development. International Book Distributing Co.
- Swarup V. 1976. Breeding Procedure for Cross-pollinated Vegetable Crops. ICAR.

VSC 504 GROWTH AND DEVELOPMENT OF VEGETABLE CROPS 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Bleasdale JKA. 1984. *Plant Physiology in Relation to Horticulture*. 2nd Ed. MacMillan.
- Gupta US. (Ed.). 1978. Crop Physiology. Oxford & IBH.
- Krishnamoorti HN. 1981. Application Plant Growth Substances and Their Uses in Agriculture. Tata-Mc Graw Hill.
- Peter KV. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency. Saini RS, Sharma KD, Dhankhar OP & Kaushik RA. (Eds.). 2001. Laboratory Manual of Analytical Techniques in Horticulture. Agrobios.
- Wien HC. (Ed.). 1997. *The Physiology of Vegetable Crops*. CABI.

VSC 505 SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behavior, seed development and maturation; methods of hybrid seed production.

UNIT III

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

UNIT VI

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

UNIT V

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

Practical

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

Suggested Readings

- Agrawal PK & Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.
- Agrawal RL. (Ed.). 1997. Seed Technology. Oxford & IBH.
- Bendell PE. (Ed.). 1998. Seed Science and Technology: Indian Forestry Species. Allied Publ.
- Fageria MS, Arya PS & Choudhary AK. 2000. Vegetable Crops: Breeding and Seed Production. Vol. I. Kalyani.
- George RAT. 1999. Vegetable Seed Production. 2nd Ed. CABI.
- Kumar JC & Dhaliwal MS. 1990. Techniques of Developing Hybrids in Vegetable Crops. Agro Botanical Publ.
- More TA, Kale PB & Khule BW. 1996. Vegetable Seed production Technology. Maharashtra State Seed Corp.
- Rajan S & Baby L Markose. 2007. Propagation of Horticultural Crops. New India Publ. Agency.
- Singh NP, Singh DK, Singh YK & Kumar V. 2006. Vegetable Seed Production Technology. International Book Distributing Co.
- Singh SP. 2001. Seed Production of Commercial Vegetables. Agrotech Publ. Academy.

VSC 506 SYSTEMATICS OF VEGETABLE CROPS 2(1+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Practical

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

Suggested Readings

- Chopra GL. 1968. *Angiosperms - Systematics and Life Cycle*.
- S. Nagin, Dutta AC. 1986. A Class Book of Botany. Oxford Univ. Press. Pandey BP. 1999. Taxonomy of Angiosperm. S. Chand & Co.
- Peter KV & Pradeep Kumar T. 2008. Genetics and Breeding of Vegetables. (Revised), ICAR.
- Soule J. 1985. Glossary for Horticultural Crops. John Wiley & Sons.
- Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. 2001. Minimal Descriptors of Agri-Horticultural Crops. Part-II: Vegetable Crops. NBPGR, New Delhi.
- Vasistha. 1998. Taxonomy of Angiosperm. Kalyani.
- Vincent ER & Yamaguchi M. 1997. World Vegetables. 2nd Ed. Chapman & Hall.

VSC 507 PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS 2(1+1)

Objective

To educate production technology of underutilized vegetable crops.

Theory

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

UNIT I Asparagus, artichoke and leek

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

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

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

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

Practical

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

Suggested Readings

- Bhat K. L. 2001. *Minor Vegetables - Untapped Potential*. Kalyani.
- lndira P & Peter KV. 1984. Unexploited Tropical Vegetables. Kerala Agricultural University, Kerala.
- Peter KV. (Ed.). 2007-08. Underutilized and Underexploited Horticultural Crops. Vols. I-IV. New India Publ. Agency.
- Rubatzky VE & Yamaguchi M. (Eds.). 1997. World Vegetables: Principles, Production and Nutritive Values. Chapman & Hall
- Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. 2001. Minimal Descriptors of Agri-Horticultural Crops. Part-II: Vegetable Crops. NBPGR, New Delhi.

VSC 508 ORGANIC VEGETABLE PRODUCTION TECHNOLOGY 2 (1+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

VSC 509 FUNDAMENTALS OF PROCESSING OF VEGETABLES 2 (1+1)

Objective

To educate principles and practices of processing of vegetable crops.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

UNIT VII

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

Practical

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

Suggested Readings

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

VSC 601 ADVANCES IN VEGETABLE PRODUCTION 3 (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; portrays and ball culture; diagnosis of nutritional and physiological disorders; analysis of physiological factors like anatomy; photosynthesis; light intensity in different cropping situation; assessing nutrient status, use of plant growth regulators; practices in herbicide application; estimating water requirements in relation to crop growth stages, maturity indices; dryland techniques for rainfed vegetable production; production constraints; analysis of different cropping system in various situation like cold and hot set; vegetable waste recycling management; quality analysis ;marketing survey of the above crops; visit to vegetable and fruit malls and packing houses.

Suggested Readings

- Bose TK & Som NG. 1986. *Vegetable Crops of India*. Naya Prokash.
- Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003.Vegetable Crops. Vols. I-III. Naya Udyog.
- Brewster JL. 1994. Onions and other Vegetable Alliums. CABI. FFTC. Improved Vegetable Production in Asia. Book Series No. 36.
- Ghosh SP, Ramanujam T, Jos JS, Moorthy SN & Nair RG. 1988. Tuber Crops. Oxford & IBH.
- Gopalakrishnan TR. 2007. Vegetable Crops. New India Publishing Agency.
- Kallo G & Singh K. (Ed.). 2001. Emerging Scenario in Vegetable Research and Development. Research Periodicals & Book Publ. House.
- Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S & Pallai SV. 1996. Tropical Tuber Crops, Problems, Prospects and Future Strategies. Oxford & IBH.
- Sin MT & Onwueme IC. 1978. The Tropical Tuber Crops. John Wiley & Sons.
- Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. Modern Technology on Vegetable Production. International Book Distr. Co.
- Singh PK, Dasgupta SK & Tripathi SK. 2006. Hybrid Vegetable Development. International Book Distr. Co.

VSC 602 ADVANCES IN BREEDING OF VEGETABLE CROPS 3 (2+1)

Objective

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

Theory

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

UNIT I	Tomato, brinjal, chilli, sweet pepper and potato
UNIT II	Cucurbits, Cabbage, cauliflower and knol-khol
UNIT III	Bhendi, onion, peas and beans, amaranthus and drumstick
UNIT IV	Carrot, beet root and radish
UNIT V	Sweetpotato, tapioca, elephant foot yam and taro

Practical

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

Suggested Readings

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

VSC 603 PROTECTED CULTIVATION OF VEGETABLE CROPS 2 (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, CO_2 and humidity on growth of different vegetables, manipulation of CO_2, light and temperature for vegetable production, fertigation.

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

Study of various types of structures, methods to control temperature, CO_2 light, media, training and pruning, maintenance of parental lines and hybrid seed production of vegetables, fertigation and nutrient management, control of insect-pests and disease in greenhouse; economics of protected cultivation, visit to established green/polyhouse/net house/shade house in the region.

Suggested Readings

- Anonymous 2003. *Proc. All India Seminar on Potential and Prospects for Protective Cultivation*. Organised by Institute of Engineers, Ahmednagar. Dec.12-13, 2003.
- Chandra S & Som V. 2000. Cultivating Vegetables in Green House. Indian Horticulture 45: 17-18.
- Prasad S & Kumar U. 2005. Greenhouse Management for Horticultural Crops. 2nd Ed. Agrobios.
- Tiwari GN. 2003. Green House Technology for Controlled Environment. Narosa Publ. House.

VSC 604 BIOTECHNOLOGY OF VEGETABLE CROPS 3 (2+1)

Objective

To teach advances in biotechnology for improvement of vegetable crops.

Theory

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

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Bajaj YPS. (Ed.). 1987. Biotechnology in Agriculture and Forestry. Vol.XIX. Hitech and Micropropagation. Springer.
- Chadha KL, Ravindran PN & Sahijram L. (Eds.). 2000. Biotechnology of Horticulture and Plantation Crops. Malhotra Publ. House.
- Debnath M. 2005. Tools and Techniques of Biotechnology. Pointer Publ. Glover MD. 1984. Gene Cloning: The Mechanics of DNA Manipulation.
- Chapman & Hall. Gorden H & Rubsell S. 1960. Hormones and Cell Culture. AB Book Publ.
- Keshavachandran R & Peter KV. 2008. Plant Biotechnology: Tissue Culture and Gene Transfer. Orient & Longman (Universal Press).
- Keshavachandran R et al. 2007. Recent Trends in Biotechnology of Horticultural Crops. New India Publ. Agency.
- Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. Biotechnology of Horticultural Crops. Vols. I-III.
- Naya Prokash. Pierik RLM. 1987. In vitro Culture of Higher Plants. Martinus Nijhoff Publ.
- Prasad S. 1999. Impact of Plant Biotechnology on Horticulture. 2nd Ed. Agro Botanica.
- Sharma R. 2000. Plant Tissue Culture. Campus Books.
- Singh BD.2001. Biotechnology. Kalyani.
- Skoog Y & Miller CO. 1957. Chemical Regulation of Growth and Formation in Plant Tissue Cultured in vitro. Attidel. II Symp. on Biotechnology Action of Growth Substance.
- Vasil TK, Vasi M, While DNR & Bery HR. 1979. Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture. Planum Press.

❖ Williamson R. 1981-86. Genetic Engineering. Vols. I-V.

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

Objective

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

Theory

UNIT I

Seed certification, objectives, organization of seed certification, minimum seed certification standards of vegetable crops, field inspection, specification for certification.

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

Agency.

VSC 606 ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

VEGETABLE SCIENCE

List of Journals

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

- Vegetable Grower
- Vegetable Science

VEGETABLE SCIENCE

Suggested Broad Topics for Master's and Doctoral Research

- Organic farming in vegetable crops
- Application of molecular markers in genetic improvement of vegetable crops
- Development of transgenic vegetables
- Growing vegetables under protected conditions
- Mulching in vegetable crops
- Micronutrients in vegetable crops
- Screening of vegetable s against abiotic stress
- Hi-tech methods for raising nursery of vegetable crops
- Dry land and coastal farming
- Drip/micro irrigation in vegetable crops
- Fertigation in vegetable crops
- Research on physiological disorders in vegetable crops
- Breeding for quality improvement
- Breeding for insect-pest and disease resistance
- Breeding for extending shelf life of vegetable crops
- Minimal processing of vegetables
- Concept of quality control in vegetable seed production
- Integrated nutrients management in vegetable crops
- Breeding for industrial and processing of vegetable crops
- Research on water management in vegetable crops
- Research on home storage of vegetable crops
- Hi-tech home gardening

FLORICULTURE AND LANDSCAPE ARCHITECTURE

Course Structure – at a Glance

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

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

College of Horticulture
Department of Floriculture and Landscape Architecture

Semester wise major courses
Master's Programme

Semester- I				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	**Page No**
1	FLA.502	Production Technology of Cut Flowers	3(2+1)	
2	FLA.503	Production Technology of Loose Flowers	3(2+1)	
3	FLA.504	Landscaping and Ornamental Gardening	3(2+1)	
4	FLA.505	Protected Floriculture	3(2+1)	
5	FLA-599	Master's Research	05	
Total			**17**	
Semester- II				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FLA-501	Breeding of Flower Crops and Ornamental Plants	3(2+1)	
2	FLA-506	Value Addition in Flowers	3(2+1)	
3	FLA-599	Master's Research	05	
Minor				
As Required by thesis problem				
Basic Supporting Course				
6	MCA-501	Computer Fundamentals and Programming	3 (2+1)	
Non Credit course				
7	PGS-502	Technical Writing and Communication Skills	1 (0+1)	
		Total		
Semester- III				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FLA-507	Turfing and Turf Management	3(2+1)	
2	FLA-508	CAD for Outdoor and Indoorscaping	2+1	
3	FLA-599	Master's Research	05	
Minor				
As Required by thesis problem				
Basic Supporting Course				
10	STAT-512	Experimental Design	3 (2+1)	
11	BPS-661	Experimental Statistics	3 (2+1)	
12	BIOCHEM-501	Basic Biochemistry	4(3+1)	
Non Credit Courses				
13	PGS-501	Library and Information Services	1(0+1)	
14	PGS-503	Intellectual Property and Its Management in Agriculture	1(1+0)	
15	PGS-504	Basic concepts in Laboratory Techniques	1 (0+1)	
16	PGS-505	Agriculture Research, Research Ethics and Rural Development Programme	1(1+0)	
17	PGS-506	Disaster Management	1(1+0)	
Total				

Semester- IV				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1				
2	FLA 591	Master's Seminar	1(1+0)	
3	FLA-599	Master's Research	05	
Basic Supporting Course				
4	STAT-511	Statistical Methods for Applied Science	2(1+1)	
Total				

Department of Floriculture and Landscape Architecture

Semester wise major courses

Ph.D. Programme

Semester- I				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	**Page No**
1	FLA 602	Advances in Flower Production Technology	3(2+1)	
2	FLA 603	Advances in Protected And Precision Floriculture	2(1+1)	
3	FLA 604	Advances in Landscape Architecture	2(1+2)	
4	FLA-699	Doctoral Research	05	
Basic Supporting Course				
5	STAT-512	Experimental Design	3 (2+1)	
6	BPS-661	Experimental Statistics	3 (2+1)	
Total				
Semester- II				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FLA-601	Advances in Breeding of Flower Crops	3(2+1)	
2	FLA-699	Doctoral Research	05	
Minor				
As Required by thesis problem				
Basic Supporting Course				
5	MCA-501	Computer Fundamentals and Programming	3 (2+1)	
Total				
Semester- III				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FLA 605	Advances in Biochemistry and Biotechnology of Flowers	3(2+1)	
2	FLA-699	Doctoral Research	05	
Minor				
As Required by thesis problem				
Total				
Semester- IV				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FLA-691	Doctoral Seminar I	1(1+0)	
2	FLA-692	Doctoral Seminar II	1(1+0)	
3	FLA-699	Doctoral Research	10	
Basic Supporting Course				
4	STAT-511	Statistical Methods for Applied Science	2(1+1)	
Total				
Semester- V				

SL	Course No	Title of the Course	Credit Hrs	
1	FLA-699	Doctoral Research	10	
Total			**10**	
Semester- VI				
SL	**Course No**	**Title of the Course**	**Credit Hrs**	
1	FLA-699	Doctoral Research	10	
Total			**10**	

FLORICULTURE AND LANDSCAPE ARCHITECTURE

Course Contents

FLA 501 BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture.* Vols. I-VI. Pointer Publ.
- Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

- Chadha KL & Choudhury B.1992. *Ornamental Horticulture in India*. ICAR.
- Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.
- Chaudhary RC. 1993. *Introduction to Plant Breeding.* Oxford & IBH. Singh BD. 1990. *Plant Breeding*. Kalyani.

FLA 502 PRODUCTION TECHNOLOGY OF CUT FLOWERS 3(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 CO_2 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, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

Practical

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

Suggested Readings

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

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

FLA 503 PRODUCTION TECHNOLOGY FOR LOOSE FLOWERS 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

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

Practical

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

Suggested Readings

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

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

- Bose TK, Maiti RG, Dhua RS & Das P. 1999. Floriculture and Landscaping. Naya Prokash.
- Chadha KL & Chaudhury B.1992. Ornamental Horticulture in India. ICAR.
- Chadha KL. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ. House.
- Lauria A & Ries VH. 2001. Floriculture – Fundamentals and Practices. Agrobios.
- Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios.
- Randhawa GS & Mukhopadhyay A. 1986. Floriculture in India. Allied Publ.
- Sheela VL. 2007. Flowers in Trade. New India Publ. Agency.
- Valsalakumari PK, Rajeevan PK, Sudhadevi PK & Geetha CK.2008.
- Flowering Trees. New India Publ. Agency.

FLA 504 LANDSCAPING AND ORNAMENTAL GARDENING 3 (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.
- Woodrow MG.1999. Gardening in India. Biotech Books.

FLA 505 PROTECTED FLORICULTURE 3 (2 + 1)

Objective

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

Theory

UNIT I

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

UNIT II

Environment control – management and manipulation of temperature, light, humidity, air and CO_2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
- Bose TK & Yadav LP. 1989. Commercial Flowers. Naya Prokash.
- Bose TK, Maiti RG, Dhua RS & Das P. 1999. Floriculture and Landscaping. Naya Prokash.
- Chadha KL. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ. House.
- Lauria A & Victor HR. 2001. Floriculture – Fundamentals and Practices Agrobios.
- Nelson PV. 1978. Green House Operation and Management. Reston Publ. Co.
- Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios
- Randhawa GS & Mukhopadhyay A. 1986. Floriculture in India. Allied Publ.
- Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.

FLA 506 VALUE ADDITION IN FLOWERS 3(2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Practical

Practices in preparation of bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands with fresh flowers; Techniques in flower arrangement; Techniques in floral decoration; Identification of plants for

dry flower making; Practices in dry flower making; Preparation of dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths, etc.; Visit to dry flower units, concrete and essential oil extraction units.

Suggested Readings

- Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
- Chadha KL.1995. *Advances in Horticulture*. Vol.XII. Malhotra Publ. House.
- Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.
- Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.
- Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 507 TURFING AND TURF MANAGEMENT 3(2+1)

Objective

To develop understanding of the principles and management of turfing.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

FLA 508 CAD FOR OUTDOOR AND INDOORSCAPING 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

FLA 601 ADVANCES IN BREEDING OF FLOWER CROPS 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

FLA 602 ADVANCES IN FLOWER PRODUCTION TECHNOLOGY 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

Propagation and multiplication; IPR issues related to propagation of materials; Greenhouse management; Soil/media decontamination techniques; Micro irrigation; nutrition and fertigation; slow release fertilizers and biofertilizers; influence of environmental parameters, light, temperature, moisture, humidity and CO_2 on growth and flowering; regulation for quality flowers.

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.
- Chadha KL & Choudhury B. 1992. *Ornamental Horticulture in India*.ICAR.
- George S & Peter KV. 2008. *Plants in a Garden*. New India Publ. Agency.
- Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.
- Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
- Reddy S, Janakiram B, Balaji T, Kulkarni. S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 603 ADVANCES IN PROTECTED AND PRECISION FLORICULTURE 2(1+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
- Bose TK, Maiti RG, Dhua RS & Das P. 1999. Floriculture and Landscaping. Naya Prokash.
- Reddy S, Janakiram B, Balaji T, Kulkarni S, & Misra RL. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.

FLA 604 ADVANCES IN LANDSCAPE ARCHITECTURE 3(1+2)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

FLA 605 ADVANCES IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS 3 (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

UNIT VII

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

Practical

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

Suggested Readings

- Chopra VL & Nasim. 1990. Genetic Engineering and Biotechnology – Concepts, Methods and Applications. Oxford & IBH.
- Debnath M. 2005. Tools and Techniques of Biotechnology. Pointer Publ.
- Dey PM & Harborne JB. 1997. Plant Biochemistry. 2nd Ed. Academic Press.
- Glover MD. 1984. Gene Cloning: The Mechanics of DNA Manipulation. Chapman & Hall.

- Goodwin TW & Mercer EI. 2003. Introduction to Plant Biochemistry. CBS.
- Gorden H & Rubsell S. 1960. Hormones and Cell Culture. AB Book Publ.
- Keshavachandran R & Peter KV. 2008. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient & Longman (Universal Press).
- Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. (Eds.). 2007. Recent Trends in Horticultural Biotechnology. Vols. I, II. New India Publishing Agency.
- Panopoulas NJ. (Ed.). 1981. Genetic Engineering in Plant Sciences. Praeger Publ.
- Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. Biotechnology of Horticultural Crops. Vols. I-III. Naya Prokash.
- Pierik RLM. 1987. In vitro Culture of Higher Plants. Martinus Nijhoff Publ.
- Prasad S. 1999. Impact of Plant Biotechnology on Horticulture. 2nd Ed. Agro Botanica.
- Sharma R. 2000. Plant Tissue Culture. Campus Books International. Singh BD. 2001. Biotechnology. Kalyani.
- Skoog Y & Miller CO. 1957. Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro. Symp. Soc. Exp. Biol. 11: 118-131.
- Vasil TK, Vasi M, While DNR & Bery HR. 1979. Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture. Planum Press.
- Williamson R. 1981-86. Genetic Engineering. Vols. I-V. www.amazon.com

FLORICULTURE AND LANDSCAPE ARCHITECTURE

List of Journals & Magazines

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

Suggested Broad Topics for Master's and Doctoral Research

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

Minor courses for PG and Ph. D. students of College of Horticulture Students

1. Agricultural Biotechnology (For Masters students)

First Semester Courses			Class Schedule					
Number	**Title**	**Credit hrs. (L-T-P)**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
ABT-501	Principles of Biotechnology (Dr. Vaishali)	3(2-0-1)	12-1		2-5	11-12		
ABT-510	General Biochemistry (Dr. R.S.Sengar)	3(3-0-0)	11-12		11-12		10-11	
Second Semester Courses								
ABT-503	Molecular Cell Biology (Dr. Mukesh)	3(3-0-0)	12-1		12-1	11-12		

Agricultural Biotechnology (For Ph.D. Students)

First Semester Courses			Class Schedule					
Number	**Title**	**Credit hrs. (L-T-P)**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
ABT-505	Plant Tissue Culture & Genetic Transformation (Dr.Pushpendra)	3(1-0-2)	2-5			2-5	10-11	
ABT-507	Genomics & Proteomics (Dr. Pushpendra)	2(2-0-0)	11-12	11-12				
Second Semester Courses								
ABT-502	Fundamentals of Molecular Biology (Dr. Vaishali)	3(3-0-0)	11-12		11-12	10-11		

2. Agricultural Engineering and Food Technology (For Masters students)

First Semester Courses			Class Schedule					
Number	**Title**	**Credit hrs. (L-T-P)**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
PFE 502	Engineering Properties of Food Materials (Er. Jaiveer Singh)	3(2-0-1)				10-11 2-5	12-1	
PFE 508	Fruits and Vegetables Process Engineering (Dr. Suresh Chandra)	3(2-0-1)	2-5	10-11	10-11			
Second Semester Courses								
PFE 503	Advanced Food Processing Engineering (Er. Neelesh Chauhan)	3(2-0-1)	3(2-0-1)	2-5	11-12		11-12	

Agricultural Engineering and Food Technology (For Ph.D. students)

First Semester Courses			Class Schedule					
Number	**Title**	**Credit hrs. (L-T-P)**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
PFE 513	Storage Engineering & Handling of Agricultural Products (Er. Neelesh Chauhan)	3(2-0-1)		2-5	11-12		11-12	
PFE 602	Advances in Food Processing (Prof. Shamser/Dr. Suresh Chandra)	3(2-0-1)	12-1	2-5	12-1			
PFE 605	Agricultural Wastes and By Products Utilization (Dr. B.R.Singh/Dr. Suresh Chandra)	3(2-0-1)		10-11		10-11	2-5	

3. Agronomy (For masters students)

First Semester Course			Class Schedule					
Number	**Title**	**Credit hrs. (L-T-P)**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
AGRON 503	Principles and Practices of Weed Management (Dr. Vivek)	3(2-0-1)			10-11	10-11 2-5		
AGRON 504	Principles and Practices of Water Management (Dr. R.K. Naresh)	3(2-0-1)		9-10 2-5			10-11	
Second Semester Courses								
AGRON 501	Modern Concept of Crop Production (Dr. R.B.Yadav/Dr. R.K.Naresh)	3(3 + 0)	10-11			9-10	9-10	
AGRON 502	Principles and practices of soil fertility and nutrient management (Dr. N.S.Rana)	3(2 + 1)		11-12 2-5			11-12	

Agronomy (For Ph.D. students)

First Semester Course			Class Schedule					
Number	**Title**	**Credit hrs. (L-T-P)**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**

AGRON 601	Current Trends in Agronomy (Dr. R.K.Naresh)	3(3-0-0)	11-12			11-12	11-12	
AGRON 602	Crop Ecology (Dr.R.B.Yadav)	2(2-0-0)			10-11	10-11		
AGRON 607	Integrated Farming System (Dr. Mukesh Kumar)	2(2-0-0)	10-11			10-11		
Second Semester Courses								
AGRON 501*	Modern Concept of Crop Production (Dr. R.B.Yadav/Dr. R.K.Naresh)	3(3 + 0)	10-11			9-10	9-10	
AGRON 502*	Principles and practices of soil fertility and nutrient management (Dr. N.S.Rana)	3(2 + 1)		11-12 2-5			11-12	
AGRON 605	Irrigation management (Dr.R.K. Naresh)	3(2-0-1)	9-10		2-5		11-12	
AGRON 606	Advances weed management (Dr. Vivek)	2(2-0-0)		9-10	9-10			
AGRON 608	Soil conservation and watershed management (Dr. R.K. Naresh)	3(2-0-1)		12-1 2-5			12-1	

*Compulsory for those students who did not studied these courses in master degree programme

4. Genetics and Plant Breeding (First Semester)

Course			Class Schedule					
Number	**Title**	**Credit hrs. (L-T-P)**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
GP-501*	Principles of Genetics (Dr. Atar Singh)	3(2-0-1)		12-1		11-12 2-5		
GP-503*	Principles of Plant Breeding (Dr.L.K.Gangwar)	3(2-0-1)		12-1	9-10	2-5		
GP-504	Principles of Quantitative Genetics (Dr. Pooran Chand)	3(2-0-1)		11-12	11-12		2-5	
GP-507	Heterosis Breeding (Dr.S.K. Singh)	2(1-0-1)		2-5		12-1		
Second Semester Courses								
GP-502	Principles of Cytogenetics (Dr. Pooran Chand)	3(2-0-1)	11-12		11-12		2-5	
GP-508	Cell Biology and Molecular Genetics (Dr. Atar Singh)	3(2-0-1)				10-11 2-5	11-12	
GP-510	Breeding for Biotic and Abiotic Stress Management (Dr. Atar Singh)	3(2-0-1)		10-11	10-11		2-5	
GP-610	In situ and Ex Situ conservation of germplasm (Dr. Atar Singh)	3(2-0-1)		10-11	10-11		2-5	

*Compulsory courses

5. Soil Science

First Semester Courses			Class Schedule					
Number	**Title**	**Credit hrs. (L-T-P)**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
SOILS 502	Soil Fertility & Fertilizer Use (Dr. B.P.Dhyani)	4 (3-0-1)	12-1 2-5		10-11	10-11		
SOILS 513	Management of Problem Soils & Waters (Dr.S.P. Singh)	3(2-0-0)				12-1	12-1 2-5	
SAC-602	Soil Biology and Biochemistry (Dr. Yogesh Kataria)							
Second Semester Courses								
SOILS 511	Analytical Techniques and Instrumental Methods in Soil and Plant Analysis (Dr. B.P.Dhyani/ Dr.U.P.Shahi)	2 (0-0-2)	2-5			2-5		

Basic Supporting Courses

First Semester Courses			Class Schedule					
Number	**Title**	**Credit hrs. (L-T-P)**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
BBC-501	Basic Biochemistry	4(3-0-1)	9-10			10-11	11-12 2-5	
MCA-502	Introduction to Networking & Internet Application	2 (1-0-1)			2-5	11-12		
STAT-512	Experimental Design	3 (2-0-1)	9-10 10-1				9-10	
STAT 513	Statistical Methods for Social Sciences	3(2-0-1)	2-5		10-11		12-1	
BPS 661	Experimental Statistics	4 (3-0-1)		9-10 10-1	11-12		10-11	
Second Semester Courses								
BPY-500	Plant Physiology	3(2-0-1)		12-1 2-5		12-1		
MCA-501	Computer Fundamentals and Programming	3(2-0-1)			12-1		12-1 2-5	
STAT-511	Statistical Methods for Applied Science	4 (3-0-1)	9-10	9-10	9-10 2-5			

***LSIS-** Students will be visiting library twice a week; each visit shall be of 3 hours, instructor will remain available therein from Mon to Thu

COMPULSORY NON-CREDIT COURSES

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

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

Course Contents

PGS 501 LIBRARY AND INFORMATION SERVICES 1 (0+1)

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e- resources access methods.

PGS 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS 1 (0+1)

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc.
To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing **-** Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; ommonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills **-** Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors);Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

- *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
- *Collins' Cobuild English Dictionary*. 1995. Harper Collins.
- Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.
- Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
- James HS. 1994. *Handbook for Technical Writing*. NTC Business Books. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
- Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
- Richard WS. 1969. *Technical Writing*. Barnes & Noble.
- Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*.
- Abhishek Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
- Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE1+0 (e-Course)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio- diversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and

Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

- Erbisch FH & Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
- Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
- *Intellectual Property Rights: Key to New Wealth Generation. 2001*. NRDC & Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. *Technology Generation and IPR Issues*. Academic Foundation.
- Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
- Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.
- *The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.*

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 1(0+1)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separator funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings

- Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
- Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (e-Course) 1(1+0)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

- Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
- Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.
- Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
- Singh K. 1998. *Rural Development -Principles, Policies and Management.* Sage Publ.

PGS 506 DISASTER MANAGEMENT (e-Course) 1 (1+0)

Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

- Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.
- Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.
- Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.

e - Resources in Horticulture

Australian Society for Horticultural Science	http://www.aushs.org.au/
Agricultural & Processed Food Products Export Development Authority (APEDA)	http://www.apeda.com/
American Society for Horticultural Science	http://www.ashs.org/
Asian Vegetable Research and Development Center (AVRDC)	http://www.avrdc.org.tw/
Australian Society for Horticultural Science	http://www.aushs.org.au/
Central Food Technological Research Institute (CFTRI)	http://www.cftri.com/
Central Institute of Medicinal & Aromatic Plants (CIMAP)	http://www.cimap.org/
Central Institute of Post harvest Engineering and Technology	http://www.icar.org.in/ciphet.html
Central Plantation Crops Research Institute (CPCRI), Kasaragod, Kerala	http://cpcri.nic.in/
Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram, Kerala	http://www.ctcri.org/

Consultative Group on International Agricultural Research, CGIAR	http://www.cgiar.org/
Coffee Board, India	http://indiacoffee.org/
Department of Agriculture and Co-operation, India	http://agricoop.nic.in/
Department of Bio-technology, India	http://dbtindia.nic.in
Department of Scientific and Industrial Research, India	http://dsir.nic.in/
FAO	http://www.fao.org/
Global Agribusiness Information Network:	http://www.fintrac.com/gain/:
Greenhouse Vegetable Information:	http://www.ghvi.co.nz/
Indian Agricultural Research Institute (IARI)	http://www.iari.res.in/
Indian Council of Agricultural Research (ICAR)	http://www.icar.org.in
Indian Institute of Horticultural Research (IIHR)	www.iihr.res.in
Indian Institute of Spices Research (IISR), Calicut, Kerala	http://www.iisr.org/
Indo-American Hybrid Seeds	www.indamseeds.com
Institute of Vegetable and Ornamental Crops	http://www.igzev.de/
Institute for Horticultural Development, Victoria, Australia	http://www.nre.vic.gov.au/agvic/ih/
Kerala Agricultural University	www.kau.edu
Iowa State University Department of Horticulture	http://www.hort.iastate.edu/
National Bureau of Plant Genetic Resources (NBPGR), India	http://nbpgr.delhi.nic.in/
National Horticulture Board (NHB), India	http://hortibizindia.nic.in/
National Institute of Agricultural Extension Management (MANAGE), India	http://www.manage.gov.in/
National Research Centre for Cashew (NRCC),	http://kar.nic.in/cashew/

India	
National Research Centre for Mushroom (NRCM), India	http://www.nrcmushroom.com/
National Research Centre for Oil Palm (NRCOP), India	http://www.ap.nic.in/nrcop
North Carolina State University, Dept. of Horticulture	http://www2.ncsu.edu/cals/hort_sci/
Oregon State University, Dept. of Horticulture	http://osu.orst.edu/dept/hort
Pineapple News	http://agrss.sherman.hawaii.edu/pineapple/pineappl.htm
Pomology Resources Center	http://www.bsi.fr/pomologie/english/pomology:
Rubber board, India	http://rubberboard.org.in/
Spice Paprika web site	http://www.paprika.deltav.hu/:
Spices Board, India	http://www.indianspices.com/
Sri Lanka Agribisness on-line	http://www.agro-lanka.org/

Sustainable Apple Production:	http://orchard.uvm.edu/
Tea Board, India	http://tea.nic.in/
The Horticultural Taxonomy Group	http://www.hortax.org.uk/
The International Society of Citriculture:	http://www.lal.ufl.edu/isc_citrus_homepage.htm
The Internet Garden	http://www.internetgarden.co.uk/
The Rose Resource	http://rose.org/
The USDA Agricultural Research Service	http://www.ars.usda.gov/
University of Florida, Dept. of Environmental Horticulture	http://hort.ifas.ufl.edu/
University of California, Fruit&Nut Research	http://fruitsandnuts.ucdavis.edu/
US Environmental Protection Agency	http://www.epa.gov/:
USDA	http://www.usda.gov/

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