NEW AND RESTRUCTURED
POST-GRADUATE CURRICULA & SYLLABIs

Horticultural Sciences

Fruit Science
Vegetable Science
Floriculture & Landscape Architecture
Plantation, Spices, Medicinal & Aromatic Crops

Education Division
Indian Council of Agricultural Research
New Delhi

April 2009
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EXECUTIVE SUMMARY

M.Sc. and Ph.D programmes are envisaged in four divisions viz, Fruit Science, Vegetable Science, Floriculture and Land Scape Architecture and Plantation Crops, Spices, Medicinal and Aromatic crops. BSMA committee for Post harvest technology will take care of the processing and post harvest technology of horticultural crops. However, relevant courses are included under each of the four divisions.

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.

Plantation Crops, Spices, Medicinal and Aromatic Crops

✧ Thrust on advances in management and crop improvement of plantation crops, spices, medicinal and aromatic crops.

✧ Biotechnology, biodiversity conservation, organic production and GAP are included.

✧ Faculty should be trained in advanced and frontier aspects of biotechnology and post harvest technology

Laboratory facilities should be strengthened for conduct of practical classes especially in biotechnology, crop improvement and post harvest technology.

One time catch up grant should be awarded to each SAU for meeting expenditure for upgrading the course requirements. Faculty training and retraining should be an integral
component. For imparting total quality management, a minimum of two faculty in each division under an SAU should be given onjob training in reputed national and international institutes.

**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.
BSMA Committee on Horticultural Sciences

(Horticulture/Vegetable crops/Pomology/Floriculture & Landscaping/Post Harvest Technology/Spices & Plantation)

(Constituted by ICAR vide Office order No. F. No. 13 (1)/2007- EQR dated January 14, 2008)

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Specialization</th>
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<tbody>
<tr>
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<td>Ex-Vice Chancellor</td>
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<tr>
<td>Convener</td>
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<tr>
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<td>Vegetable crops</td>
</tr>
<tr>
<td>Prof. &amp; Dean</td>
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<td>Professor</td>
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<td>Dean (PGS)</td>
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<td><strong>Dr. P.K. Chattopadhyay</strong>*</td>
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<td>Plantation Crops</td>
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<td>Division fo Floriculture &amp; Lanscaping, IARI, New Delhi</td>
<td>Floriculture</td>
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<td>Principal Scientist</td>
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<td><strong>Dr. M. K. Rana</strong></td>
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<td>Vegetable crops</td>
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<tr>
<td>Professor</td>
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<tr>
<td>Member Secretary</td>
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* did not attend any meeting

**Co-opted Members**

1. **Dr M. Jawaharlal**
   Prof. & Head, Dept. of Floriculture & Landscaping, Horticultural College and Research Institute, TNAU, Coimbatore

2. **Dr K. Rajmani**
   Prof. & Head, Dept. of Spices and Plantation Crops, TNAU, Coimbatore

3. **Dr T. N. Balamohan**
   Prof. & Head, Fruits, College of Horticulture and Research Institute, TNAU, Coimbatore

4. **Dr. T. Pradeep Kumar**
   Associate Prof. Dept. of Olericulture, College of Horticulture, KAU
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 meagre 0.4%. The 10th Five Year Plan envisaged growth rate of 8% in Horticulture. The 11th Plan initiated a massive National Horticulture Mission with an outlay of Rs. 20,000 crores. The Private sector has come up with massive investments in corporate farming, processing and marketing.

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
4. M. Sc. (Hort) - Plantation crops, spices, medicinal and aromatic crops

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 through a series of workshops conducted at IARI New Delhi, UAS Bangalore, TNAU Coimbatore and KAU Trichur. 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. Some new courses like climate management in Horticultural production 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 considerable expenses on medicine. A separate M. Sc. Programme is suggested.

M. Sc. and Ph. D. syllabi in Vegetable Science were drafted with inputs from the distinguished faculties of IARI New Delhi, IIHR Bangalore, UAS Bangalore, TNAU Coimbatore and KAU Trichur. 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. Introduction and history were avoided from the syllabi as these are already covered under B. Sc. programme. 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 separate M. Sc. programme is hence suggested. M. Sc. and Ph. D. syllabi in Floriculture were drafted with major inputs from TNAU Coimbatore and KAU Trichur. 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.

**Plantation, Spices, Medicinal & Aromatic Crops**

Plantation, spices, medicinal and aromatic crops occupy a major chunk of cultivable area in south and north east states. These are major export earning crops. They play a major role in nutritional security and save considerable expenses on medicine. M. Sc. and Ph. D. syllabi in plantation, spices, medicinal and aromatic crops were drafted through a series of workshops conducted at IARI New Delhi, UAS Bangalore, TNAU Coimbatore and KAU Trichur. Core and optional courses for these 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 PG syllabi. Biodiversity and conservation of perennial crops, IPR issues, GI and IPR, patenting, organic crop production and GAP are included in the syllabus. Some new courses like climate management in Horticultural production are included in the syllabus. Advanced aspects in production and breeding of fruits and plantation crops 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.
ORGANIZATION OF COURSE CONTENTS
& 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

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<th>Subject</th>
<th>Master’s programme</th>
<th>Doctoral programme</th>
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<td><strong>Total Credits</strong></td>
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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**

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<th>CODE</th>
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<td>FSC 501*</td>
<td>TROPICAL AND DRY LAND FRUIT PRODUCTION</td>
<td>2+1</td>
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<tr>
<td>FSC 502*</td>
<td>SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION</td>
<td>2+1</td>
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<tr>
<td>FSC 503*</td>
<td>BIODIVERSITY AND CONSERVATION OF FRUIT CROPS</td>
<td>2+1</td>
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<td>FSC 504</td>
<td>CANOPY MANAGEMENT IN FRUIT CROPS</td>
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<td>FSC 505</td>
<td>PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS</td>
<td>2+1</td>
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<td>FSC 506*</td>
<td>BREEDING OF FRUIT CROPS</td>
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<td>FSC 507</td>
<td>POST HARVEST TECHNOLOGY FOR FRUIT CROPS</td>
<td>2+1</td>
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<td>FSC 508</td>
<td>GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS</td>
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<td>BIOTECHNOLOGY OF HORTICULTURAL CROPS</td>
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<td>FSC 510</td>
<td>ORGANIC HORTICULTURE</td>
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<td>FSC 511</td>
<td>PROTECTED CULTIVATION</td>
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<td>GAP FOR HORTICULTURAL CROPS</td>
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<td>CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION</td>
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<td>FSC 591</td>
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<td>MASTER’S RESEARCH</td>
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<td>FSC 601**</td>
<td>ADVANCES IN BREEDING OF FRUIT CROPS</td>
<td>2+1</td>
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<td>FSC 602**</td>
<td>ADVANCES IN PRODUCTION OF FRUIT CROPS</td>
<td>2+1</td>
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<td>FSC 603</td>
<td>ADVANCES IN GROWTH REGULATION OF FRUIT CROPS</td>
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<td>FSC 604</td>
<td>GENOMICS AND BIOINFORMATICS IN HORTICULTURE</td>
<td>2+1</td>
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<td>FSC 605</td>
<td>BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS</td>
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<td>FSC 691</td>
<td>DOCTORAL SEMINAR I</td>
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<tr>
<td>FSC 699</td>
<td>DOCTORAL RESEARCH</td>
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*Compulsory for Master’s programme; **Compulsory for Doctoral programme*
FRUIT SCIENCE

Course Contents

FSC 501  TROPICAL AND DRY LAND FRUIT PRODUCTION 2+1

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

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

Crops
UNIT I: Mango and Banana
UNIT II: Citrus and Papaya
UNIT III: Guava, Sapota and Jackfruit
UNIT IV: Pineapple, Annonas and Avocado
UNIT V: Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics

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

Suggested Readings
Nakasone HY & Paul RE. 1998. Tropical Fruits. CABI.
FSC 502 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 2+1

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

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

Crops
UNIT I: Apple, pear, quince, grapes
UNIT II: Plums, peach, apricot, cherries, hazlenut
UNIT III: Litchi, loquat, persimmon, kiwifruit, strawberry
UNIT IV: Nuts- walnut, almond, pistachio, pecan
UNIT V: Minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate

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

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

FSC 503 BIODIVERSITY AND CONSERVATION OF FRUIT CROPS 2+1

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

Theory
UNIT I
Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.
UNIT II
Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation in situ and ex situ.

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

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

UNIT V
GIS and documentation of local biodiversity, Geographical indication.

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

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

Suggested Readings

FSC 504 CANOPY MANAGEMENT IN FRUIT CROPS 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

FSC 505 PROPAGATION AND NURSERY MANAGEMENT 2+1 FOR FRUIT CROPS

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

Theory
UNIT I

UNIT II

UNIT III

UNIT IV

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, micrografting, hardening. Visit to TC labs and nurseries.

**Suggested Readings**


**FSC 506**

**BREEDING OF FRUIT CROPS**

2+1

**Objective**

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

**Theory**

Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, 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**


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

FSC 507  POST HARVEST TECHNOLOGY FOR FRUIT CROPS  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, 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
Mitra SK. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CABI.
FSC 508 GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS

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, abscissic 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
FSC 509

BIOTECHNOLOGY OF HORTICULTURAL CROPS 2+1

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

Theory

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

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

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

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

UNIT V

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


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**FSC 510**

**ORGANIC HORTICULTURE**  

**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, framework for GAP, case studies, HACCP analysis, residue analysis in organic products, documentation for certification, visit to fields cultivated under organic practices

Suggested Readings
Gaur AC, Nebalkantan S & Dargan KS. 1984 *Organic Manures*. ICAR.

FSC 511 PROTECTED FRUIT CULTURE 2+1

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

Theory
UNIT I
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, CO₂, 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
FSC 512  GAP FOR HORTICULTURAL CROPS  1+0

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

Theory
UNIT I
Genesis of GAP – definition/description, components listed by FAO, framework.
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

FSC 513  CLIMATE MANAGEMENT IN HORTICULTURAL  1+0 PRODUCTION

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 CO₂, 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

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
Rao GSLHV, Rao GGSN, Rao VUM & Ramakrishnan YS. 2008. Climate Change and Agriculture over India. ICAR.

FSC 601 ADVANCES IN BREEDING OF FRUIT CROPS 2+1

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

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

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

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

Suggested Readings

FSC 602 ADVANCES IN PRODUCTION OF FRUIT CROPS 2+1
Objective
To keep abreast with latest developments and trends in production technology of fruit crops.

Theory
National and International scenario in fruit production, Recent advances in propagation - root stock influence, planting systems, High density planting, crop modeling , Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, , Total quality management(TQM) - Current topics.

Crops
UNIT I: Mango and banana
UNIT II: Papaya, grapes and citrus
UNIT III: Guava, sapota, pomegranate and aonla
UNIT IV: Pineapple, avocado, jack fruit and fig
UNIT V: Apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Practical

Suggested Readings
Bose TK, Mitra SK & Sanyal D. (Eds.). 2001. Fruits -Tropical and
Objective

Appraisal on the advances in growth regulation of fruit crops.

Theory

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

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

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

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

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

Practical

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

Suggested Readings


FSC 604 GENOMICS AND BIOINFORMATICS IN HORTICULTURE  2+1

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

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

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

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

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

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

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

Practical

Suggested Readings
FSC 605 BIOTIC AND ABIOTIC STRESS MANAGEMENT IN 2+1 HORTICULTURAL CROPS

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

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

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

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

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

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

Practical
Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors,
RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and water shed locations.

**Suggested Readings**


Nickell LG. 1983. *Plant Growth Regulating Chemicals*. CRC.


FRUIT SCIENCE

List of Journals & Magazines

✧ Acta Horticulture
✧ 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
✧ 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

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* Compulsory for Master’s programme; **Compulsory for Doctoral programme
VEGETABLE SCIENCE

Course Contents

VSC 501 PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 2+1

Objective
To educate production technology of cool season vegetables.

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

UNIT I
Potato

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

UNIT III
Root crops: carrot, radish, turnip and beetroot

UNIT IV
Bulb crops: onion and garlic

UNIT V
Peas and broad bean, green leafy cool season vegetables

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

Suggested Readings

**VSC 502 PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS**

**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**


Pandey AK & Mudranalay V. (Eds.). *Vegetable Production in India: Important Varieties and Development Techniques*.


VSC 503  BREEDING OF VEGETABLE CROPS  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
VSC 504  GROWTH AND DEVELOPMENT OF VEGETABLE CROPS    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, gibberellins, cytokinins 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**


**VSC 505     SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS 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 behaviour, 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
George RAT. 1999. Vegetable Seed Production. 2nd Ed. CABI.

VSC 506 SYSTEMATICS OF VEGETABLE CROPS 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
VSC 507  PRODUCTION TECHNOLOGY OF UNDEREXPLOITED 2+1 VEGETABLE CROPS

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


VSC 508  ORGANIC VEGETABLE PRODUCTION TECHNOLOGY   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
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
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

VSC 509  FUNDAMENTALS OF PROCESSING OF VEGETABLES   2+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
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.
VSC 601 ADVANCES IN VEGETABLE PRODUCTION 2+1

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

Theory
Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of:

UNIT I
Tomato, brinjal, chilli, sweet pepper and potato

UNIT II
Cucurbits, cabbage, cauliflower and knol-khol

UNIT III
Bhendi, onion, peas and beans, amaranthus and drumstick

UNIT IV
Carrot, beet root and radish

UNIT V
Sweet potato, tapioca, elephant foot yam and taro

Practical
Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; 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

Brewster JL. 1994. Onions and other Vegetable Alliums. CABI.
FFTC. Improved Vegetable Production in Asia. Book Series No. 36.

VSC 602 ADVANCES IN BREEDING OF VEGETABLE CROPS 2+1

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

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

UNIT I
Tomato, brinjal, chilli, sweet pepper and potato

UNIT II
Cucurbits, Cabbage, cauliflower and knol-khol

UNIT III
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

VSC 603  PROTECTED CULTIVATION OF VEGETABLE CROPS  1+1

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

Theory
Crops: Tomato, capsicum, cucumber, melons and lettuce

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

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

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

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

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

Practical
Study of various types of structures, methods to control temperature, CO\textsubscript{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

**VSC 604 BIOTECHNOLOGY IN VEGETABLE CROPS 2+1**

**Objective**
To teach advances in biotechnology for improvement of vegetable crops.

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

UNIT I

UNIT II
Protoplast culture and fusion; construction, identification and characterization of somatic hybrids and cybrids, wide hybridization, embryo rescue of recalcitrant species, \textit{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


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
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


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
✧ HortScience
✧ 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 Areca nut 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 vegetables 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

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*Compulsory for Master’s programme; ** Compulsory for Doctoral programme
FLORICULTURE AND LANDSCAPE ARCHITECTURE

Course Contents

FLA 501 BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS 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
Objective
To impart basic knowledge about the importance and production technology of cut flowers grown in India.

Theory

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

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

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

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

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

Crops:
Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, 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
Chadha KL & Chaudhury B. 1992. Ornamental Horticulture in India. ICAR.
FLA 503  PRODUCTION TECHNOLOGY FOR LOOSE FLOWERS    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

FLA 504  LANDSCAPING AND ORNAMENTAL GARDENING  2+1

Objective
Familiarization with principles and practices of landscaping and ornamental gardening.

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

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

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

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

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

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


**FLA 505** 
**PROTECTED FLORICULTURE** 

**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 CO₂; 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

**FLA 506 VALUE ADDITION IN FLOWERS 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**


**FLA 507 TURFING AND TURF MANAGEMENT 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, aeration, 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.
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
FLA 601 ADVANCES IN BREEDING OF FLOWER CROPS 2+1

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

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

UNIT II
Specific objectives of breeding in flower crops, Methods of breeding suited to seed and 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 Vitro 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

FLA 602 ADVANCES IN FLOWER PRODUCTION TECHNOLOGY 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; Microirrigation; nutrition and fertigation; slow release fertilizers and biofertilizers; influence of environmental parameters, light, temperature, moisture, humidity and CO₂ 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; Microirrigation; Nutrition and fertigation. Special practices- Pinching, netting, disbudding, defoliation and chemical pruning; Photoperiodic and chemical induction of flowering; Assessing harvest indices; Post-harvest handling; Tissue analysis; Preparation of floral decoratives; Extraction of floral concrete and oils; case studies; visit to commercial cut flower units.

Suggested Readings

FLA 603 ADVANCES IN PROTECTED AND PRECISION FLORICULTURE

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

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

FLA 604       ADVANCES IN LANDSCAPE ARCHITECTURE       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

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

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

Theory
UNIT I
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, cytodiifferentiation, 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

UNIT VI

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

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

**Suggested Readings**


Goodwin TW & Mercer EI. 2003. *Introduction to Plant Biochemistry.* CBS.


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
### PLANTATION, SPICES, MEDICINAL & AROMATIC CROPS
#### Course Structure – at a Glance

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<tr>
<th>CODE</th>
<th>COURSE TITLE</th>
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<td>PSMA 501*</td>
<td>PRODUCTION OF PLANTATION CROPS</td>
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<td>PSMA 502*</td>
<td>PRODUCTION TECHNOLOGY OF SPICE CROPS</td>
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* Compulsory for M. Sc. Programme; ** Compulsory for Doctoral programme
PLANTATION, SPICES, MEDICINAL & AROMATIC CROPS

Course Contents

PSMA 501      PRODUCTION OF PLANTATION CROPS       2+1

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

Theory
Role of plantation crops in national economy, export potential, IPR issues, clean development mechanism, classification and varietal wealth. Plant multiplication including in vitro multiplication, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micro nutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting. Cost benefit analysis, organic farming, management of drought, precision farming.

Crops
UNIT I: Coffee and tea
UNIT II: Cashew and cocoa
UNIT III: Rubber, palmyrah and oil palm
UNIT IV: Coconut and arecanut
UNIT V: Wattle and betel vine

Practical
Description of botanical and varietal features, selection of mother palms and seedlings in coconut and arecanut, soil test crop response studies and manuring practices, pruning and training, maturity standards, harvesting, Project preparation for establishing plantations, Visit to plantations.

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

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

UNIT I
Black pepper, cardamom
UNIT II
Clove, cinnamon and nutmeg, allspice
UNIT III
Turmeric, ginger and garlic
UNIT IV
Coriander, fenugreek, cumin, fennel, ajowain, dill, celery
UNIT V
Tamarind, garcinia and vanilla

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

Suggested Readings
Gupta S. (Ed.). Hand Book of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.
PSMA 503 PRODUCTION TECHNOLOGY FOR MEDICINAL AND Aromatic Crops

Objective
To impart comprehensive knowledge about the production technology of medicinal and aromatic crops.

Theory
UNIT I
Herbal industry, WTO scenario, Export and import status, Indian system of medicine, Indigenous Traditional Knowledge, IPR issues, Classification of medicinal crops, Systems of cultivation, Organic production, Role of institutions and NGO’s in production, GAP in medicinal crop production.

UNIT II
Production technology for Senna, Periwinkle, Coleus, Aswagandha, Glory Lily, Sarpagandha, Dioscorea sp., Aloe vera, Phyllanthus amarus, Andrographis paniculata.

UNIT III
Production technology for Medicinal solanum, Isabgol, Poppy, Safed musli, Stevia rebaudiana, Mucuna pruriens, Ocimum sp.

UNIT IV
Post harvest handling – Drying, Processing, Grading, Packing and Storage, processing and value addition; GMP and Quality standards in herbal products.

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

UNIT VI
Aromatic industry, WTO scenario, Export and import status, Indian perfumery industry, History, Advancements in perfume industry.

UNIT VII
Production technology for palmarosa, lemongrass, citronella, vettiver, geranium, artemisia, mentha, ocimum, eucalyptus, rosemary, thyme, patchouli, lavender, marjoram, oreganum.

UNIT VIII
Post-harvest handling, Distillation methods, advanced methods, Solvent extraction process, steam distillation, Perfumes from non-traditional plants, Quality analysis, Value addition, Aroma chemicals, quality standards and regulations.
UNIT IX
Institutional support and international promotion of essential oil and perfumery products.

Practical
Botanical description, Propagation techniques, Maturity standards, Digital documentation, Extraction of secondary metabolites, Project preparation for commercially important medicinal crops, Visit to medicinal crop fields, Extraction of Essential oils, Project preparation for commercially important Aromatic crops, Visit to distillation and value addition units – Visit to CIMAP.

Suggested Readings
Khan IA & Khanum A. Role of Bio Technology in Medicinal and Aromatic Plants. Vol. IX. Vkaaz Publ.

PSMA 504    BREEDING OF PLANTATION CROPS AND SPICES    2+1
Objective
To impart comprehensive knowledge about the principles and practices of breeding of plantation crops and spices.

Theory
Species and cultivars, cytogenetics, survey, collection, conservation and evaluation, blossom biology, breeding objectives, approaches for crop improvement, introduction, selection, hybridization, mutation breeding, polyploid breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, molecular aided breeding and biotechnological approaches, marker-assisted selection, bioinformatics, IPR issues, achievements and future thrusts.

Crops
UNIT I: Coffee and tea
UNIT II: Cashew and cocoa
UNIT III: Rubber, palmyrah and oil palm
UNIT IV: Coconut and arecanut
UNIT V: Black pepper and cardamom
UNIT VI: Ginger and turmeric
UNIT VII: Fenugreek, coriander, fennel, celery and ajwain
UNIT VIII: Nutmeg, cinnamon, clove and allspice

Practical
Characterization and evaluation of germplasm accessions, Blossom biology, studies on pollen behaviour, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for biotic and abiotic stresses, haploid culture, protoplast culture and fusion- induction of somaclonal variation and screening the variants. Identification and familiarization of spices; floral biology anthesis; fruit set; selfing and crossing techniques; description of varieties. Salient features of improved varieties and cultivars from public and private sector, bioinformatics, visit to radiotracer laboratory, national institutes for plantation crops and plant genetic resource centers, genetic transformation in plantation crops for resistance to biotic stress/quality improvement etc.

Suggested Readings

PSMA 505 BREEDING OF MEDICINAL AND AROMATIC CROPS 2+1

Objective
To impart comprehensive knowledge about the principles and practices of breeding of plantation crops and spices.

Theory
UNIT I
Plant bio-diversity, conservation of germplasm, IPR issues, Major objectives of breeding of Medicinal and Aromatic Crops, Scope for introduction; cytogenetic background of important Medicinal and Aromatic Crops; Scope for improvement of Medicinal and Aromatic Crops through selection, intra and interspecific hybridization, induced autotetraploidy, mutation breeding and biotechnological approaches.
UNIT II
Breeding for yield and quality improvement in medicinal plants, Breeding
for high herbage yield, essential oil and quality components, secondary metabolites in medicinal and aromatic crops; Genetics of active principles and assay techniques useful in evaluation of breeder’s material. Breeding problems in seed and vegetatively propagated medicinal and aromatic crops.

UNIT III
Achievements and prospects in breeding of medicinal crops, viz. Cassia angustifolia, Catharanthus roseus, Gloriosa superba, Coleus forskohlii, Stevia, Withania somnifera, Papaver somniferum, Plantago ovata, Dioscorea sp.

UNIT IV
Prospects in breeding of medicinal crops, viz. Chlorophytum sp, Rauvolfia serpentina, Aloe vera, Ocimum sp, Phyllanthus amarus, Solanum sp.

UNIT V
Prospects in breeding of aromatic crops viz., Geranium, vettiver, Lemon grass, Palmarosa, citronella, Rosemary, Patchouli, Eucalyptus, Artemisia and Mint.

Practical
Description of Botanical features, Cataloguing of cultivars, varieties and species in medicinal and aromatic crops, Floral Biology, Selfing and crossing, Evaluation of hybrid progenies, Induction of economic mutants, High alkaloid and high essential oil mutants, evolution of mutants through physical and chemical mutagens, Introduction of polyploidy, Screening of plants for biotic and abiotic stress and environmental pollution, in-vitro breeding in medicinal and aromatic crops.

Suggested Readings
Thakur RS, Pauri HS & Hussain A. 1989. Major Medicinal Plants of India. CSIR.

PSMA 506 PROCESSING OF PLANTATION CROPS, SPICES 2+1 MEDICINAL AND AROMATIC PLANTS

Objective
To facilitate deeper understanding on principles and practices of post harvest technology of plantation crops, spices, medicinal and aromatic crops.
Theory

UNIT I
Commercial uses of spices and plantation crops. Processing of major spices - cardamom, black pepper, ginger, turmeric, chilli and paprika, vanilla, cinnamon, clove, nutmeg, allspice, coriander, fenugreek, curry leaf. Extraction of oleoresin and essential oils.

UNIT II
Processing of produce from plantation crops, viz. coconut, arecanut, cashewnut, oil palm, palmyrah, date palm, cocoa, tea, coffee, rubber etc.

UNIT III
Processing of medicinal plants – dioscorea, gloriosa, stevia, coleus, ashwagandha, tulsi, isabgol, safed musli, senna, aloe, catharanthus, etc. Different methods of drying and storage. Microbial contamination of stored product. Influence of temperature and time combination on active principles.

UNIT IV
Extraction and analysis of active principles using TLC / HPLC / GC. Distillation, solvent extraction from aromatic plants – davana, mint, rosemary, rose, citronella, lavender, jasmine, etc. Study of aroma compounds and value addition. Nano-processing technology in medicinal and aromatic plants.

Practical
Study of processing of different spices and plantation crops. Study of processing of medicinal plants, their drying and storage. Extraction of active ingredients from different spices and herbs using TLC, HPLC, GC/CG-MS technology. Distillation, solvent extraction from aromatic plants – davana, mint, rosemary, citronella, lavender, jasmine, etc. Identification of different odoriferous factors in essential oil with GLC/GC-MS. Physico-chemical and sensory evaluation of oils and oleoresin. Value added products from spices and plantation crops.

Suggested Readings
Objective
To educate principles, concepts and production of organic farming in spice and plantation crops.

Theory
UNIT I
Importance, principles, perspective, concept and component of organic production of spice and plantation crops.

UNIT II
Organic production of spice crops and plantation crops, viz. pepper, cardamom, turmeric, ginger, cumin, vanilla, coconut, coffee, cocoa, tea, arecanut.

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

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

Practical

Suggested Readings


Theory

UNIT I
Introduction, importance, present status and future prospects, origin, distribution, species, varieties, economic parts and their uses in different diseases, Biodiversity and conservation, RET (Rare, Endangered and Threatened) and MPCAs (Medicinal Plants Conservation Areas).

UNIT II
Underutilized species – importance, traditional usage, ISM, TCM, Functional foods.

UNIT III
Production technology of underutilized medicinal crops– Morinda citrifolia, Caesalpinia sappan, Caralluma, Terminalia chebula, Strychnos nuxvomica, Solanum trilobatum, Physalis, Aegle marmelos, Alpinia sp., Anthosepalus kadamba, Costus.

UNIT IV
Production technology of underutilized aromatic crops– Curcuma aromatica, C. caesia, Coleus aromaticus, Ocimum kilimanjaricum, Bursera.

UNIT V
National and international conservation network, IPR issues, Promotion of under utilized species, Processing and value addition, Marketing.

Practical
Case studies.

Suggested Readings

PSMA 601 ADVANCES IN PRODUCTION OF PLANTATION CROPS 2+1

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

Theory
Plantation crops – area and production, export potential - varietal wealth and appraisal on the crop improvement in plantation crops. Mass multiplication techniques, High density planting, systems of cultivation,
multitier cropping, companion cropping, studies of on canopy and root management, photosynthetic efficiencies of crops at different tiers, Biotic and abiotic factors on growth and productivity, nutritional requirements, role of macro and micro nutrients, Nutrient deficiency symptoms, growth regulators, water requirement, fertigation, soil and moisture conservation practices, Drought management, permanent vegetation management, Basin management, training and pruning, maturity indices, harvesting, curing, processing and value addition, grading, packing and storage, role of commodity boards in plantation crop development, Production of plantation crops through GAP, GMP, HACCP.

**Crops**

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<tr>
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<tr>
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<td>Wattle and betelvine</td>
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**Practical**

Description of botanical and varietal features—selection of mother palms and elite clones, Clonal fidelity testing, nursery techniques and propagation methods, High density planting, training and pruning practices, fertigation and foliar nutrition, shade regulation, maturity standards, harvesting, curing, processing and grading, project preparation for establishing new plantations, visit to plantation gardens, commodity boards and plantation based industries.

**Suggested Readings**

Grimwood BE. 1975. *Coconut Palm Products*. FAO.

**PSMA 602 ADVANCES IN SPICE PRODUCTION 2+1**

**Objective**

To educate advances in production technology of spice crops.

**Theory**

Spices- current status on area and production, state, national and global scenario of spices, global trade, problems encountered in spices productivity, systems of cultivation, varieties, soil and climate, propagation
techniques and nursery management, planting systems and methods, cropping pattern, permanent floor management concepts in mulching and weed management, canopy and root studies under different spice-based cropping systems, shade and basin management, INM practices, irrigation and fertigation techniques, chemical regulation of crop productivity, IPM, clean cultivation strategies, harvesting, Post-harvest and quality management for value added spices, quality standards, GAP and GMP for spices production, quality control and certification. Protected cultivation of high value spice crops. Value addition and byproduct utilization. Precision farming and organic farming in spice crops. Commodity Boards in spices development

UNIT I: Pepper and cardamom
UNIT II: Nutmeg, clove, cinnamon and allspice
UNIT III: Turmeric, ginger, garcinia, tamarind and garlic
UNIT IV: Coriander, fenugreek, fennel, cumin and vanilla
UNIT V: Paprika and important herbal spices

Suggested Readings
Yagna Narayan Ayer AK. 1960. Cultivation of Cloves in India. ICAR.

Objective
To keep abreast with latest developments and trends in production technology of medicinal and aromatic crops.
Theory

UNIT I

UNIT II
Indian traditional wisdom and Heritage- Indian herbal wealth, Documentations, Databases, Scientific validation, Production Problems of Medicinal and Aromatic plants, Export and import status. WTO scenario - Principles and guidelines for GAP, GCP and GMP in medicinal crops.

UNIT III
Climate, Soil and substrate culture, Improved varieties, Organic production, Nutrition and irrigation requirements, inter culture, mulching, Weed control, Maturity indices and Harvesting, Post-harvest handling, Drying, Processing, Grading, Packing and Storage, Quality standards in medicinal plants, Biotechnological approaches for advances in phytochemical extraction technologies, Separation of Bio-molecules, Distillation methods, Essential oil extraction and value addition in aromatic plants, Phytochemicals and drug development.

UNIT IV
Medicinal crops : Coleus forskohlii, Glory lily, Senna, Periwinkle, Stevia rebaudiana, Aswagandha, Sarpagandha, Aloe vera, Dioscorea sp, Phyllanthus amarus, Andrographis paniculata, Medicinal solanum, Isabgol, Poppy, Digitalis sp, Commiphora sp, Ipecac, Henbane, Ocimum sp., Centella, Bacopa, Saraca indica and Bael.

UNIT V
Aromatic crops: Palmarosa, Lemongrass, citronella, vetiver, Geranium, Artemisia, Mentha, Ocimum, Eucalyptus, Rosemary, Thyme, patchouli.

Practical
Identification and documentation- propagation in medicinal crops, Maturity standards, Harvesting and Drying techniques, Processing and grading, Analysis of bio-molecules, Extraction of secondary metabolites, identification and characterization of - secondary metabolites, Essential oils, Visit to commercial medicinal plants field, Visit to GMP phytochemical extraction and value addition unit.

Suggested Readings
Khan IA & Khanum A. 2001 Role of Biotechnology in Medicinal and Aromatic Plants. Vol. IX. Vikaat Publ.
Prajapati ND, Paero Hit SS, Sharma AK & Kumar T. 2006. A Hand Book
PSMA 604  ADVANCES IN BREEDING OF PLANTATION CROPS  2+1 AND SPICES

Objective
To update knowledge on the recent research trends in the field of breeding of plantation crops and spices.

Theory
Evolutionary mechanisms, adaptation and domestication, genetic resources, genetic divergence, cytogenetics, variations and natural selection, types of pollination and fertilization mechanisms, sterility and incompatibility system, recent advances in crop improvement efforts, introduction and selection, chimeras, clonal selections, intergeneric, interspecific and intervarietal hybridization, heterosis breeding, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, genetics of important traits and their inheritance pattern, molecular and transgenic approaches and other biotechnological tools in improvement of selected spice and plantation crops.

Crops
UNIT I:   Coffee and tea
UNIT II: Cashew and cocoa
UNIT III: Rubber, palmyrah and oil palm
UNIT IV: Coconut and arecanut
UNIT V: Pepper and cardamom
UNIT VI: Nutmeg, clove, cinnamon and allspice
UNIT VII: Turmeric, ginger, garcinia, tamarind and garlic
UNIT VIII: Coriander, fenugreek, fennel, cumin and vanilla

Practical
Description and cataloguing of germplasm, pollen viability tests, pollen germination, survey and clonal selection, screening techniques for abiotic stresses, screening and rating for pest, disease and stress resistance in inbreds and hybrids, estimation of quality and processing characters for quality improvement, use of mutagenes and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding and in vitro breeding techniques.

Suggested Readings

**PSMA 605 ADVANCES IN BREEDING OF MEDICINAL AND AROMATIC CROPS**

**Objective**
To update knowledge on the recent research trends in the field of breeding of medicinal and aromatic crops with special emphasis on tropical, subtropical and temperate 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 alkaloids and secondary metabolites.

UNIT II
Methods of breeding suited to seed and vegetative propagated crops. Polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility. Breeding for resistance to pests, diseases, nematodes in medicinal and aromatic crops.

UNIT III

UNIT IV
Specific breeding objectives in medicinal and aromatic crops, Genetic bio diversity, Breeding problems and improvements in Henbane aromatic grasses, Geranium, Patchouli, Artemisia, Rosemary, Thyme, Sage, Marjoram, Fever few.

UNIT V
Biotechnological approaches for crop improvement of medicinal and aromatic crops.

**Practical**
Description of crops and cultivars, Cataloguing of species and cultivars, floral biology, selfing and crossing, evaluation of hybrid progenies, Induction of economic, colour mutants, Increased alkaloid content in medicinal crops,
high essential oil content in aromatic plants, Physical and chemical mutagens, Induction of polyploidy, Screening of plants for biotic and abiotic stresses and environmental pollution, in-vitro breeding in flower crops, medicinal and aromatic crops.

**Suggested Readings**


Handa SS & Kaul MK. 1982. *Cultivation and Utilization of Medicinal Plants*. NISC, CSIR.


Thakur RS, Pauri HS & Hussain A. 1989. *Major Medicinal Plants of India*. CSIR.

**PSMA 606 BIOTECHNOLOGY IN PLANTATION CROPS AND SPICES 1+1**

**Objective**

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

**Theory**

**Crops:** Coconut, oil palm, coffee, tea, cocoa, pepper, cardamom, turmeric, ginger, vanilla

**UNIT I**

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

**UNIT II**

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

**UNIT III**

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

**UNIT IV**

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

**UNIT V**

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


PSMA 607 POST-HARVEST PROCESSING AND EXTRACTION IN MEDICINAL AND AROMATIC PLANTS

Objective

To teach advances in post harvest processing and extraction of economically important medicinal and aromatic crops.

Theory

UNIT I

Post-harvest handling of plant material, preparation of plant material for packaging and extraction. Methods of extraction of secondary metabolites
from medicinal crops like sarpagandha, steroid-bearing solanums, ashwagandha, henbane, periwinkle, senna, costus, coleus, etc.

UNIT II
Procedures and equipments used for extraction of active principles. Principles and practices of different types of chromatographs - paper, thin-layer, column, gas and high performance liquid chromatography and mass spectroscopy. Preservation of plant extracts and their trade mechanisms.

UNIT III
Harvesting, drying, handling and preparation of different aromatic crops - jasmine, tuberose, oil-bearing rose, scented geranium, patchouli, davana, mints, basilis, etc., for essential oil extraction.

UNIT IV
Principles and practices of different types of extraction - distillation, solvent extraction, supercritical fluid extraction, etc. Fine flavour and perfume extraction. Qualitative determination of essential oils. In vitro production of biomass and organic extraction of oils. Quality analysis and characterization through chromatographs.

UNIT V
Commercial uses of essential oils, aromatherapy, etc. Commercial utilization of spent material. Storage of essential oils.

Practical
Identification of different economic parts of medicinal and aromatic crops. Preparation of plant material for extraction. Study of different extraction methods. Study of solvents used in extraction of concrete and absolutes. Extraction of crude drugs and essential oils from different medicinal and aromatic crops respectively. Handling of different chromatographs. Quality analysis of essential oils - both physical and chemical, determination of phenol values, acid values, alcohol values, etc. Sensory evaluation of essential oils. Storage studies in essential oils. Visit to commercial extraction and product development units.

Suggested Readings


Objective
To teach advances in environmental management of horticultural crops.

Theory

UNIT I
Environmental complex, interaction of ecological factors in horticultural crop production, interaction of physiographic factors in horticultural crop production. Geo-chemical and hydrological cycles and their impact on ecosystems.

UNIT II
Global warming- carbon trading role of greenhouse gases, elevated CO₂ and its impact on productivity of horticultural systems. Habitat ecology, changes in habitats and its impact on horticultural production, Habitat analysis, conservation biology, domestication. Forest ecosystem and its evolution to a hort-ecosystem.

UNIT III
Phytogeography, changes in land use pattern and its impact on horticultural crop production. Natural resource management in hortisystems. Subsistence farming systems of the world, threat and challenges.

UNIT IV
Environmental pollution in horti systems, chemicals, fertilizers, etc. Waste management in processing industry, phytoremediation. Alternate farming systems, horticultural therapy. Environmental policy & legislation in India, International treatise and Summit, Biodiversity Board, Act, etc.

Practical

Suggested Readings
PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS

List of Journals & Magazines

- Acta Horticulture
- Haryana Journal of Horticulture Science
- Horticulture Reviews
- HortScience
- Indian Horticulture
- Indian Journal of Arid Horticulture
- Indian Journal of Horticulture
- Indian Spice
- 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 Plantation Crops
- Journal of Spices and Aromatic Crops
- Scientia Horticulture
- South Indian Horticulture
- Spice India

Suggested Broad Topics for Master’s and Doctoral Research

- Micro-propagation of plantation crops and spices
- Application of genetic engineering in plantation crops, spices, medicinal and aromatic crops
- Use of molecular markers in plantation crops, spices, medicinal and aromatic crops
- Plantation crops, spices, medicinal and aromatic crop improvement
- Crop selection for biotic and abiotic stresses
- Diagnostic and recommended integrated system in cultivation of plantation crops, spices, medicinal and aromatic crops
- Precision farming in plantation crops, spices, medicinal and aromatic crops
- Root distribution studies in plantation crops, spices, medicinal and aromatic crops
- Organic production of plantation crops, spices, medicinal and aromatic crops
- Post harvest management of plantation crops, spices, medicinal and aromatic crops
- Value addition in plantation crops, spices, medicinal and aromatic crops
- Rejuvenation of plantations and spice garden
- Research on burning problems in plantation crops, spices, medicinal and aromatic crops like root wilt of coconut, yellowing of arecanut, foot rot of black pepper, katte disease of cardamom etc.
## e - Resources in Horticulture

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<tr>
<th>Organization</th>
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<tr>
<td>Agricultural &amp; Processed Food Products Export Development Authority (APEDA)</td>
<td><a href="http://www.apeda.com/">http://www.apeda.com/</a></td>
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<tr>
<td>American Society for Horticultural Science</td>
<td><a href="http://www.ashs.org/">http://www.ashs.org/</a></td>
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<td>Asian Vegetable Research and Development Center (AVRDC)</td>
<td><a href="http://www.avrdc.org.tw/">http://www.avrdc.org.tw/</a></td>
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<tr>
<td>Central Food Technological Research Institute (CFTRI)</td>
<td><a href="http://www.cftiri.com/">http://www.cftiri.com/</a></td>
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<tr>
<td>Central Institute of Medicinal &amp; Aromatic Plants (CIMAP)</td>
<td><a href="http://www.cimap.org/">http://www.cimap.org/</a></td>
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<tr>
<td>Central Institute of Post harvest Engineering and Technology</td>
<td><a href="http://www.icar.org.in/ciphet.html">http://www.icar.org.in/ciphet.html</a></td>
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<tr>
<td>Central Plantation Crops Research Institute (CPCRI), Kasaragod, Kerala</td>
<td><a href="http://cpcrinc.in/">http://cpcrinc.in/</a></td>
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<td>Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram, Kerala</td>
<td><a href="http://www.ctcri.org/">http://www.ctcri.org/</a></td>
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<tr>
<td>Consultative Group on International Agricultural Research, CGIAR</td>
<td><a href="http://www.cgiar.org/">http://www.cgiar.org/</a></td>
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<td>Coffee Board, India</td>
<td><a href="http://indiacoffee.org/">http://indiacoffee.org/</a></td>
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<td>Department of Agriculture and Co-operation, India</td>
<td><a href="http://agricoop.nic.in/">http://agricoop.nic.in/</a></td>
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<td>Department of Bio-technology, India</td>
<td><a href="http://dbtindia.nic.in">http://dbtindia.nic.in</a></td>
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<tr>
<td>Department of Scientific and Industrial Research, India</td>
<td><a href="http://dsir.nic.in">http://dsir.nic.in</a></td>
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<td>FAO</td>
<td><a href="http://www.fao.org/">http://www.fao.org/</a></td>
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<td>Greenhouse Vegetable Information:</td>
<td><a href="http://www.ghvi.co.nz/">http://www.ghvi.co.nz/</a></td>
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<tr>
<td>Indian Agricultural Research Institute (IARI)</td>
<td><a href="http://www.iari.res.in">http://www.iari.res.in</a></td>
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<td>Indian Council of Agricultural Research (ICAR)</td>
<td><a href="http://www.icar.org.in">http://www.icar.org.in</a></td>
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<td>Indian Institute of Horticultural Research (IIHR)</td>
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<td>Indian Institute of Spices Research (IISR), Calicut, Kerala</td>
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<td>Indo-American Hybrid Seeds</td>
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<td>Institute of Vegetable and Ornamental Crops</td>
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<td>Kerala Agricultural University</td>
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<td>Iowa State University Department of Horticulture</td>
<td><a href="http://www.hort.iastate.edu/">http://www.hort.iastate.edu/</a></td>
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<td>National Bureau of Plant Genetic Resources (NBPGR), India</td>
<td><a href="http://nbpgr.delhi.nic.in">http://nbpgr.delhi.nic.in</a></td>
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<td>National Horticulture Board (NHB), India</td>
<td><a href="http://hortibizindia.nic.in">http://hortibizindia.nic.in</a></td>
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<td>National Institute of Agricultural Extension Management (MANAGE), India</td>
<td><a href="http://www.manage.gov.in">http://www.manage.gov.in</a></td>
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<td>National Research Centre for Cashew (NRCC),</td>
<td><a href="http://kar.nic.in/cashew/">http://kar.nic.in/cashew/</a></td>
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<td>India</td>
<td><a href="http://www.nrcmushroom.com/">http://www.nrcmushroom.com/</a></td>
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<td>National Research Centre for Oil Palm</td>
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<td>Pineapple News</td>
<td><a href="http://agrss.sherman.hawaii.edu/pineapple/pineappl.htm">http://agrss.sherman.hawaii.edu/pineapple/pineappl.htm</a></td>
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<td>Pomology Resources Center</td>
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<td>Spice Paprika web site</td>
<td><a href="http://www.paprika.deltav.hu/">http://www.paprika.deltav.hu/</a></td>
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<td>Spices Board, India</td>
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<td>Sustainable Apple Production:</td>
<td><a href="http://orchard.uvm.edu/">http://orchard.uvm.edu/</a></td>
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<td>Tea Board, India</td>
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<td>The Horticultural Taxonomy Group</td>
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<td>The International Society of Citriculture:</td>
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COMPULSORY NON-CREDIT COURSES
(Compulsory for Master’s programme in all disciplines; Optional for Ph.D. scholars)

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<tr>
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<tbody>
<tr>
<td>PGS 501</td>
<td>LIBRARY AND INFORMATION SERVICES</td>
<td>0+1</td>
</tr>
<tr>
<td>PGS 502</td>
<td>TECHNICAL WRITING AND COMMUNICATIONS SKILLS</td>
<td>0+1</td>
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<td>PGS 503</td>
<td>INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE</td>
<td>1+0</td>
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<td>PGS 504</td>
<td>BASIC CONCEPTS IN LABORATORY TECHNIQUES</td>
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<tr>
<td>PGS 505</td>
<td>AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES</td>
<td>1+0</td>
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<tr>
<td>PGS 506</td>
<td>DISASTER MANAGEMENT</td>
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**Course Contents**

**PGS 501 LIBRARY AND INFORMATION SERVICES 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 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.; commonly 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**


**PGS 503**

**INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE**

**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 biodiversity 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

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 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, separatory 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
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 Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Objective

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


ACKNOWLEDGEMENTS

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