

## PG Syllabus of Fruit Science Department Semester-I

### I. Course Title : Tropical Fruit Production

### II. Course Code : FSC 501

### III. Credit Hours : (2+1)

### IV. Why this course ?

Tropical fruits occupy a distinct place in global fruit production. Apart from ecological specificities, tropical fruits enjoy favour among masses being delicious and nutritious. As such, the course has been designed to provide update knowledge on various production technologies of tropical fruits on sustainable basis.

### V. Aim of the course

To impart comprehensive knowledge to the students on cultural and management practices for growing tropical fruits.

The course is organised as follows:

No.	Blocks	Units
1	Introduction	I Importance and Background
2	Agro-Techniques	I Propagation, Planting and Orchard Floor Management
3	Crop Management	I Flowering, Fruit-Set and Harvesting

### VI. Theory

#### Block 1: Introduction

**Unit I:** Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

#### Block 2: Agro-techniques

**Unit I:** Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

#### Block 3: Crop Management

**Unit I:** Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

### Crops

Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla, Ber etc.

### VII. Practicals

- Distinguished features of tropical fruit species, cultivars and rootstocks (2);
- Demonstration of planting systems, training and pruning (3);
- Hands on practices on pollination and crop regulation (2);
- Leaf sampling and nutrient analysis (3);
- Physiological disorders-malady diagnosis (1);
- Physico-chemical analysis of fruit quality attributes (3);
- Field/ Exposure visits to tropical orchards (1);
- Project preparation for establishing commercial orchards (1).

### VIII. Teaching Methods/ Activities

- Class room Lectures

- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

### **IX. Learning outcome**

The students are expected to equip themselves with know-how on agro-techniques for establishment and management of an orchard leading to optimum and quality fruit production of tropical fruits.

### **X. Suggested Reading**

- Bartholomew DP, Paull RE and Rohrbach KG. 2002. The Pineapple: Botany, Production, and Uses. CAB International.
- Bose TK, Mitra SK and Sanyal D. 2002. Fruits of India – Tropical and Sub-Tropical. 3rd Edn. Naya Udyog, Kolkata.
- Dhillon WS. 2013. Fruit Production in India. Narendra Publ. House, New Delhi.
- Iyer CPA and Kurian RM. 2006. High Density Planting in Tropical Fruits: Principles and Practices. IBDC Publishers, New Delhi.
- Litz RE. 2009. The Mango: Botany, Production and Uses. CAB International.
- Madhawa Rao VN. 2013. Banana. ICAR, New Delhi.
- Midmore D. 2015. Principles of Tropical Horticulture. CAB International.
- Mitra SK and Sanyal D. 2013. Guava, ICAR, New Delhi.
- Morton JF. 2013. Fruits of Warm Climates. Echo Point Book Media, USA.
- Nakasome HY and Paull RE. 1998. Tropical Fruits. CAB International.
- Paull RE and Duarte O. 2011. Tropical Fruits (Vol. 1). CAB International.
- Rani S, Sharma A and Wali VK. 2018. Guava (*Psidium guajava* L.). Astral, New Delhi.
- Robinson JC and Saúco VG. 2010. Bananas and Plantains. CAB International.
- Sandhu S and Gill BS. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi.
- Schaffer B, Wolstenholme BN and Whiley AW. 2013. The Avocado: Botany, Production and Uses. CAB International.
- Sharma KK and Singh NP. 2011. Soil and Orchard Management. Daya Publishing House, New Delhi.
- Valavi SG, Peter KV and Thottappilly G. 2011. The Jackfruit. Stadium Press, USA.

### **I. Course Title : Subtropical and Temperate Fruit Production**

### **II. Course Code : FSC 502**

### **III. Credit Hours : (2+1)**

### **IV. Why this course ?**

Agro-climatic diversity in India facilitates growing a wide range of fruits extending from tropical to subtropical to temperate fruits and nuts. To highlight their ecological specificities, seasonal variations and pertinent cultural practices, a course is designed exclusively for subtropical and temperate fruits.

### **V. Aim of the course**

To impart comprehensive knowledge to the students on cultural and management practices for growing subtropical and temperate fruits.

The course is organised as follows:

<b>No.</b>	<b>Blocks</b>	<b>Units</b>
1	Introduction	Importance and Background
2	Agro-Techniques	Propagation, Planting and Orchard Floor Management
3	Crop Management	Flowering, Fruit-Set and Harvesting

## **VI. Theory**

### **Block 1: Introduction**

**Unit I:** Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements.

### **Block 2: Agro-Techniques**

**Unit I:** Propagation, Planting and Orchard Floor Management: Propagation, planting systems and densities, training and pruning, rejuvenation and replanting, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

### **Block 3: Crop Management**

**Unit I:** Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders- causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

### **Crops**

Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.

## **VII. Practicals**

- Distinguished features of fruit species, cultivars and rootstocks (2);
- Demonstration of planting systems, training and pruning (3);
- Hands on practices on pollination and crop regulation (2);
- Leaf sampling and nutrient analysis (3);
- Physiological disorders-malady diagnosis (1);
- Physico-chemical analysis of fruit quality attributes (3);
- Field/ Exposure visits to subtropical and temperate orchards (1);
- Project preparation for establishing commercial orchards (1).

## **VIII. Teaching Methods/ Activities**

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

## **IX. Learning outcome**

After successful completion of the course, the student are expected to equip themselves with principles and practices of producing subtropical (citrus, grapes, litchi, pomegranate, etc.) and temperate fruits (apple, pear, peach, plum, apricot, cherries, berries, kiwifruit, etc.) and nuts (almond, walnut, pecan, etc.)

## **X. Suggested Reading**

- Chadha KL and Awasthi RP. 2005. The Apple. Malhotra Publishing House, New Delhi.
- Chadha TR. 2011. A Text Book of Temperate Fruits. ICAR, New Delhi
- Childers NF, Morris JR and Sibbett GS. 1995. Modern Fruit Science: Orchard and Small Fruit Culture. Horticultural Publications, USA.
- Creasy G and Creasy L. 2018. Grapes. CAB International.
- Davies FS and Albrigo LG. 1994. Citrus. CAB International.
- Dhillon WS. 2013. Fruit Production in India. Narendra Publishing House, New Delhi.
- Jackson D, Thiele G, Looney NE and Morley-Bunker M. 2011. Temperate and Subtropical Fruit Production. CAB International.
- Ladanyia M. 2010. Citrus Fruit: Biology, Technology and Evaluation. Academic Press.

Layne DR and Bassi D. 2008. The Peach: Botany, Production and Uses. CABI.  
 Menzel CM and Waite GK. 2005. Litchi and Longan: Botany, Production and Uses. CAB International.  
 Pandey RM and Randey SN. 1996. The Grape in India. ICAR, New Delhi.  
 Rajput CBS, and Haribabu RS. 2006. Citriculture, Kalyani Publishers, New Delhi.  
 Sandhu S and Gill BS. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi.  
 Sharma RM, Pandey SN and Pandey V. 2015. The Pear – Production, Post-harvest Management and Protection. IBDC Publisher, New Delhi.  
 Sharma RR and Krishna H. 2018. Textbook of Temperate Fruits. CBS Publishers and Distributors Pvt. Ltd., New Delhi.  
 Singh S, Shivshankar VJ, Srivastava AK and Singh IP. 2004. Advances in Citriculture. NIPA, New Delhi.  
 Tromp J, Webster AS and Wertheim SJ. 2005. Fundamentals of Temperate Zone Tree Fruit Production. Backhuys Publishers, Lieden, The Netherlands.  
 Webster A and Looney N. Cherries: Crop Physiology, Production and Uses. CABI.  
 Westwood MN. 2009. Temperate Zone Pomology: Physiology and Culture. Timber Press, USA.

**I. Course Title : Propagation and Nursery Management in Fruit Crops**

**II. Course Code : FSC 503**

**III. Credit Hours : (2+1)**

**IV. Why this course ?**

Availability of sufficient and healthy planting material is pivotal for expanding fruit culture. This necessitates requisite skill and efficient multiplication protocols for raising plants and their in house management prior to distribution or field transfer, hence the course is developed.

**V. Aim of the course**

To understand the principles and methods of propagation and nursery management in fruit crops. The course is organised as follows:

No.	Blocks	Units
1	Introduction	I General Concepts and Phenomena
2	Propagation	I Conventional Asexual Propagation, II Micropropagation
3	Nursery	I Management Practices and Regulation

**VI. Theory**

**Block 1: Introduction**

**Unit 1:** General Concepts and Phenomena: Introduction, understanding cellular basis for propagation, sexual and asexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of fruit crops, dormancy, hormonal regulation of seed germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing.

**Block 2: Propagation**

**Unit I:** Conventional Asexual Propagation: Cutting- methods, rooting of soft and hardwood cuttings under mist and hotbeds. Use of PGR in propagation, Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods. Budding and grafting – principles and methods, establishment and management of bud wood bank. Stock, scion and inter stock relationship  
 – graft incompatibility, physiology of rootstock and top working.

**Unit II:** Micropropagation: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques – in-vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules.

**Block 3: Nursery**

**Unit I: Management Practices and Regulation: Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, nursery accreditation, import and export of seeds and planting material and quarantine.**

### **VII. Practical**

- Hands on practices on rooting of dormant and summer cuttings (3);
- Anatomical studies in rooting of cutting and graft union(1);
- Hands on practices on various methods of budding and grafting (4);
- Propagation by layering and stooling (2);
- Micropropagation- explant preparation, media preparation, culturing – meristem tip culture, axillary bud culture, micro-grafting, hardening (4);
- Visit to commercial tissue culture laboratories and accredited nurseries (2).

### **VIII. Teaching Methods/ Activities**

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

### **IX. Learning outcome**

The student would be expected to equip to acquire skills and knowledge on principles and practices of macro and micropropagation and the handling of propagated material in nursery.

### **X. Suggested Reading**

- Bose TK, Mitra SK and Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkatta.
- Davies FT, Geneve RL and Wilson SB. 2018. Hartmann and Kester's Plant Propagation Principles and Practices. Pearson, USA/ PrenticeHall of India. New Delhi.
- Gill SS, Bal JS and Sandhu AS. 2016. Raising Fruit Nursery. Kalyani Publishers, New Delhi.
- Jain S and Ishil K. 2003. Micropropagation of Woody Trees and Fruits. Springer.
- Jain S and Hoggmann H. 2007. Protocols for Micropropagation of Woody Trees and Fruits. Springer.
- Joshi P. 2015. Nursery Management of Fruit Crops in India. NIPA, New Delhi.
- Love et al. 2017. Tropical Fruit Tree Propagation Guide. UH-CTAHR F\_N\_49. College of Tropical Agriculture and Human Resources University of Hawaii at Manwa, USA.
- Peter KV, eds. 2008. Basics of Horticulture. New India Publishing Agency, New Delhi.
- Rajan S and Baby LM. 2007. Propagation of Horticultural Crops. NIPA, New Delhi.
- Sharma RR. 2014. Propagation of Horticultural Crops. Kalyani Publishers, New Delhi.
- Sharma RR and Srivastav M. 2004. Propagation and Nursery Management. Intl. Book Publishing Co., Lucknow.
- Singh SP. 1989. Mist Propagation. Metropolitan Book Co.
- Singh RS. 2014. Propagation of Horticultural Plants: Arid and Semi-Arid Regions. NIPA, New Delhi.
- Tyagi S. 2019. Hi-Tech Horticulture. Vol I: Crop Improvement, Nursery and Rootstock Management. NIPA, New Delhi.

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## **Semester-II**

**I. Course Title : Breeding of Fruit Crops**

**II. Course Code : FSC 504**

**III. Credit Hours : (2+1)**

**IV. Why this course ?**

Development of genetically improved varieties and rootstock is a continuous process which is realized through selection and breeding approaches. This is necessary to enhance the productivity

and meet ever-changing climatic conditions and market/ consumer preferences. As such, a course is formulated to generate know-how on genetic and breeding aspects of fruit crops.

#### **V. Aim of the course**

To impart comprehensive knowledge on principles and practices of fruit breeding.

The course organisation is as under:

<b>No.</b>	<b>Blocks</b>	<b>Units</b>
1	Introduction	Importance, Taxonomy and Genetic Resources
2	Reproductive Biology	Blossom Biology and Breeding Systems
3	Breeding approaches	Conventional and Non-Conventional Breeding

#### **VI. Theory**

##### **Block 1: Introduction**

**Unit I:** Importance, Taxonomy and Genetic Resources: Introduction and importance, origin and distribution, taxonomical status – species and cultivars, cytogenetics, genetic resources.

##### **Block 2: Reproductive Biology**

**Unit I:** Blossom Biology and Breeding Systems: Blossom biology, breeding systems – spontaneous mutations, polyploidy, incompatibility, sterility, parthenocarpy, apomixis, breeding objectives, ideotypes.

##### **Block 3: Breeding Approaches**

**Unit I:** Conventional and Non-Conventional Breeding: Approaches for crop improvement – direct 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 thrusts.

##### **Crops**

Mango, Banana, Pineapple, Citrus, Grapes, Litchi, Guava, Pomegranate, Papaya, Apple, Pear, Plum, Peach, Apricot, Cherries, Strawberry, Kiwifruit, Nuts

#### **VII. Practicals**

- Exercises on bearing habit, floral biology (2);
- Pollen viability and fertility studies (1);
- Hands on practices in hybridization (3);
- Raising and handling of hybrid progenies (2);
- Induction of mutations and polyploidy (2);
- Evaluation of biometrical traits and quality traits (2);
- Screening for resistance against abiotic stresses (2);
- Developing breeding programme for specific traits (2);
- Visit to research stations working on fruit breeding (1).

#### **VIII. Teaching Methods/ Activities**

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

#### **IX. Learning outcome**

After successful completion of the course, the students are expected to • Have an understanding on importance and peculiarities of fruit breeding

- Have an updated knowledge on reproductive biology, genetics and inherent breeding systems.
- Have detailed knowledge of various methods/ approaches of breeding fruit crops

## **X. Suggested Reading**

- Abraham Z. 2017. Fruit Breeding. Agri-Horti Press, New Delhi.  
Badenes ML and Byrne DH. 2012. Fruit Breeding. Springer Science, New York.  
Dinesh MR. 2015. Fruit Breeding, New India Publishing Agency, New Delhi.  
Ghosh SN, Verma MK and Thakur A. 2018. Temperate Fruit Crop Breeding- Domestication to Cultivar Development. NIPA, New Delhi.  
Hancock JF. 2008. Temperate Fruit Crop Breeding: Germplasm to Genomics. Springer Science, New York.  
Jain SN and Priyadarshan PM. 2009. Breeding Plantation and Tree Crops: Tropical Species. Springer Science, New York.  
Jain S and Priyadarshan PM. 2009. Breeding Plantation and Tree Crops: Temperate Species. Springer Science, New York.  
Janick J and Moore JN. 1996. Fruit Breeding. Vols. I–III. John Wiley & Sons, USA.  
Kumar N. 2014. Breeding of Horticultural Crops: Principles and Practices. NIPA, N. Delhi.  
Moore JN and Janick J. 1983. Methods in Fruit Breeding. Purdue University Press, USA.  
Ray PK. 2002. Breeding Tropical and Subtropical Fruits. Narosa Publ. House, New Delhi.

## **I. Course Title : Systematics of Fruit Crops**

### **II. Course Code : FSC 505**

### **III. Credit Hours : (2+1)**

### **IV. Why this course ?**

Life forms and their behaviour are best understood if properly described to the stake holders. Therefore, identification and characterization are pre-requisites to distinctly describe the plant species. The fruit crop species are no exception, and thus an exclusive course on their categorisation and description exhibiting a great deal of variation.

### **V. Aim of the course**

To acquaint with the classification, nomenclature and description of various fruit crops.

The course is organised as under:

<b>No.</b>	<b>Blocks</b>	<b>Units</b>
1	Biosystematics	Nomenclature and Classification
2	Botanical Keys and Descriptors	Identification and Description
3	Special Topics	Registration and Modern Systematics

## **VI. Theory**

### **Block 1: Biosystematics**

**Unit I:** Nomenclature and Classification: Biosystematics – introduction and significance; history of nomenclature of cultivated plants, classification and nomenclature systems; International code of nomenclature for cultivated plants

### **Block 2: Botanical Keys and Descriptors**

**Unit I:** Identification and Description: Methods of identification and description of cultivated fruit and nut species and their wild relatives features; development of plant keys for systematic identification and classification. Development of fruit crop descriptors- based upon Bioersivity International Descriptors and UPOV/ DUS test guidelines, botanical and pomological description of major cultivars and rootstocks of tropical, subtropical and temperate fruits and nut crops

### **Block 3: Special Topics**

Unit I: Registration and Modern Systematics: Registration, Use of chemotaxonomy, biochemical and molecular markers in modern systematics

### VII. Practicals

- Exercises on identification and pomological description of various fruit species and cultivars (6);
- Development of descriptive blanks vis-a-vis UPOV/ DUS test guidelines and Bioversity International (4);
- Descriptors for developing fruit species and cultivar descriptive databases (4);
- Visits to major germplasm centres and field genebanks (2).

### VIII. Teaching Methods/ Activities

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

### IX. Learning outcome

After successful completion of the course, the students would be able to—

- Categorise different fruit species into broad groups.
- Identify various fruit cultivars on basis of distinguishing features
- Characterize fruit cultivars for description, registration and protection

### X. Suggested Reading

- ASHS. 1997. The Brooks and Olmo Register of Fruit and Nut Varieties. 3rd Ed. ASHS Press.
- Bhattacharya B and Johri BM. 2004. Flowering Plants: Taxonomy and Phylogeny. Narosa Pub. House, New Delhi.
- Pandey BP. 1999. Taxonomy of Angiosperms. S. Chand & Co. New Delhi.
- Pareek OP and Sharma S. 2017. Systematic Pomology. Scientific Publishers, Jodhpur.
- Sharma G, Sharma OC and Thakur BS. 2009. Systematics of Fruit Crops. NIPA, New Delhi.
- Simpson M. 2010. Plant Systematics. 2nd Edn. Elsevier.
- Spencer RR, Cross R and Lumley P. 2003. Plant Names. 3rd Ed. A Guide to Botanical Nomenclature, CISRO, Australia.
- Srivastava U, Mahajan RK, Gangopadhyay KK, Singh M and Dhillon BS. 2001. Minimal Descriptors of Agri-Horticultural Crops. I: Fruits. NBPGR, New Delhi.
- Zielinski QB. 1955. Modern Systematic Pomology. Wm. C. Brown Co., Iowa, USA.

### I. Course Title : Canopy Management of Fruit Crops

### II. Course Code : FSC 506

### III. Credit Hours : (1+1)

### IV. Why this course ?

Plant architecture plays an important role in enhancing photosynthetic efficiency and resultant quantity and quality of the fruit produce. Manipulation of plant growth and development can be done by employing different training and pruning procedures besides through the use of growth regulators, specific rootstocks, etc. Hence this course is developed to address the aforesaid issues.

### V. Aim of the course

To impart knowledge on principles and practices in management of canopy architecture for quality fruit production.

The course organisation is as follows:

No.	Blocks	Units
1	Canopy Architecture	Introduction, types and Classification
2	Canopy Management	Physical Manipulation and Growth regulation



## **VI. Theory**

### **Block 1: Canopy Architecture**

**Unit I:** Introduction, Types and Classification: Canopy management – importance and factors affecting canopy development. Canopy types and structures, canopy manipulation for optimum utilization of light

and its interception. Spacing and utilization of land area – Canopy classification.

### **Block 2: Canopy Management**

**Unit I:** Physical Manipulation and Growth Regulation: Canopy management through rootstock and scion. Canopy management through plant growth regulators, training and pruning and management practices. Canopy development and management in relation to growth, flowering, fruiting and fruit quality.

## **VII. Practicals**

- Study of different types of canopies (2);
- Training of plants for different canopy types (2);
- Canopy development through pruning (2);
- Understanding bearing behaviour and canopy management in different fruits (2);
- Use of plant growth regulators (2);
- Geometry of planting (1);
- Development of effective canopy with support system (2);
- Study on effect of different canopy types on production and quality of fruits (2).

## **VIII. Teaching Methods/ Activities**

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

## **IX. Learning outcome**

After successful completion of the course, the students are expected to learn

- The basic principles of canopy management to modify plant architecture
- The skills on training and pruning of fruit crops, and growth regulation

## **X. Suggested Reading**

Bakshi JC, Uppal DK and Khajuria HN. 1988. The Pruning of Fruit Trees and Vines. Kalyani Publishers, New Delhi.

Chadha KL and Shikhamany SD. 1999. The Grape, Improvement, Production and Post Harvest Management. Malhotra Publishing House, Delhi.

Iyer CPA and Kurian RM. 2006. High Density Planting in Tropical Fruits: Principles and Practices. IBDC Publishers, New Delhi.

Pradeepkumar T. 2008. Management of Horticultural Crops. NIPA, New Delhi.

Singh G. 2010. Practical Manual on Canopy Management in Fruit Crops. Dept. of Agriculture and Co-operation, Ministry of Agriculture (GoI), New Delhi.

Srivastava KK. 2012. Canopy Management in Fruits. ICAR, New Delhi

## **I. Course Title : Growth and Development of Fruit Crops**

## **II. Course Code : FSC 507**

## **III. Credit Hours : (2+1)**

## **IV. Why this course ?**

The underlying principles and parameters of growth and development needs to be understood for harnessing maximum benefits in term of yield and quality. External environment and inherent hormonal and metabolic pathways considerably determine growth dynamics. Thus, a course is

formulated to develop know-how on physiological and physical aspects of growth and development processes.

#### **V. Aim of the course**

To develop comprehensive understanding on growth and development of fruit crops.

The course is structured as under:-

<b>No.</b>	<b>Blocks</b>	<b>Units</b>
1	Introduction	General Concepts and Principles
2	Environment and Development	Climatic Factors, Hormones and Developmental Physiology
3	Stress Management	Strategies for Overcoming Stress

#### **VI. Theory**

##### **Block 1: Introduction**

**Unit I:** General Concepts and Principles: Growth and development- definition, parameters of growth and development, growth dynamics and morphogenesis.

##### **Block 2: Environment and Development**

**Unit I:** Climatic Factors, Hormones and Developmental Physiology: Environmental impact on growth and development- effect of light, temperature, photosynthesis and photoperiodism, vernalisation, heat units and thermoperiodism. Assimilate partitioning, influence of water and mineral nutrition in growth and development; concepts of plant hormone and bioregulators, history, biosynthesis and physiological role of auxins, gibberellins, cytokinins, abscissic acid, ethylene, growth inhibitors and retardant, brassinosteroids, other New PGRs. 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.

##### **Block 3: Stress Management**

**Unit I:** Strategies for Overcoming Stress: Growth and developmental process during stress – manipulation of growth and development, impact of pruning and training, chemical manipulations and Commercial application of PGRs in fruit crops, molecular and genetic approaches in plant growth and development.

#### **VII. Practicals**

- Understanding dormancy mechanisms in fruit crops and seed stratification (2);
- Techniques of growth analysis (2);
- Evaluation of photosynthetic efficiency under different environments (2);
- Exercises on hormone assays (2);
- Practicals on use of growth regulators (2);
- Understanding ripening phenomenon in fruits (2);
- Study on impact of physical manipulations on growth and development (1);
- Study on chemical manipulations on growth and development (1);
- Understanding stress impact on growth and development (1).

#### **VIII. Teaching Methods/ Activities**

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

#### **IX. Learning outcome**

Consequent upon successful completion of the course, the students are expected to have

- Equipped with understanding of various growth and development processes
- Learned about the role of environment and growth substances

- Acquired the skills to realise optimum growth and development under stress conditions

### X. Suggested Reading

Bhatnagar P. 2017. Physiology of Growth and Development of Horticultural Crops. Agrobios (India).  
 Buchanan B, Gruissem W and Jones R. 2002. Biochemistry and Molecular Biology of Plants. John Wiley & Sons, NY, USA.  
 Dhillon WS and Bhatt ZA. 2011. Fruit Tree Physiology. Narendra Publishing House, New Delhi.  
 Durner E. 2013. Principles of Horticultural Physiology. CAB International.  
 Epstein E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. John Wiley & Sons, NY, USA.  
 Faust M. 1989. Physiology of Temperate Zone Fruit Trees. John Wiley & Sons, NY, USA.  
 Fosket DE. 1994. Plant Growth and Development: a Molecular Approach. Academic Press, USA.  
 Leopold AC and Kriedermann PE. 1985. Plant Growth and Development. 3rd Ed. McGraw-Hill, New Delhi.  
 Roberts J, Downs S and Parker P. 2002. Plant Growth Development. In: Salisbury FB and Ross CW. (Eds.) Plant Physiology. 4th Ed. Wadsworth Publications, USA.  
 Schafer, B. and Anderson, P. 1994. Handbook of Environmental Physiology of Fruit Crops. Vol. 1 & 2. CRC Press. USA.  
 Seymour GB, Taylor JE and Tucker GA. 1993. Biochemistry of Fruit Ripening. Chapman & Hall, London.

### I. Course Title : Nutrition of Fruit Crops

### II. Course Code : FSC 508

### III. Credit Hours : (2+1)

### IV. Why this course ?

Nutrients play a significant role in almost every growth and development process determining vigour, yield and quality of fruits. Henceforth, a course is designed to have an in depth study of various nutrients, their uptake and use efficiency in realizing sustainable fruit production

### V. Aim of the course

To acquaint with principles and practices involved in nutrition of fruit crops

The course is organised as under:-

No.	Blocks	Units
1	Introduction	General Concepts and Principles
2	Requirements and Applications	Diagnostics, Estimation and Application
3	Newer Approaches	Integrated Nutrient Management (INM)

### VI. Theory

#### Block 1: Introduction

Unit I: General Concepts and Principles: Importance and history of nutrition in fruit crops, essential plant nutrients, factors affecting plant nutrition; nutrient uptake and their removal from soil.

#### Block 2: Requirements and Applications

Unit I: Diagnostics, Estimation and Application: Nutrient requirements, root distribution in fruit crops, soil and foliar application of nutrients in major fruit crops, fertilizer use efficiency. Methods and techniques for evaluating the requirement of macro- and micro-elements, Diagnostic and interpretation techniques including DRIS. Role of different macro and micro-nutrients, their deficiency and toxicity disorders, corrective measures to overcome deficiency and toxicity disorders.

#### Block 3: Newer Approaches

**Unit I:** Integrated Nutrient Management (INM): Fertigation in fruit crops, biofertilizers and their use in INM systems.

### **VII. Practicals**

- Visual identification of nutrient deficiency symptoms in fruit crops (2);
- Identification and application of organic, inorganic and bio-fertilizers (1);
- Soil/ tissue collection and preparation for macro- and micro-nutrient analysis (1);
- Analysis of soil physical and chemical properties- pH, EC, Organic carbon (1);
- Determination of N,P,K and other macro- and micronutrients (6);
- Fertigation in glasshouse and field grown horticultural crops (2);
- Preparation of micro-nutrient solutions, their spray and soil applications (2).

### **VIII. Teaching Methods/ Activities**

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

### **IX. Learning outcome**

After successful completion of the course, the students would be expected to

- Know the importance and various types of nutrients and their uptake mechanisms
- Analyse soil and plant status with respect to various nutrients
- Make use of corrective measures to overcome deficiency or toxicity

### **X. Suggested Reading**

- Atkinson D, Jackson JE and Sharples RO. 1980. Mineral Nutrition of Fruit Trees. Butterworth – Heinemann.
- Bould C, Hewitt EJ and Needham P. 1983. Diagnosis of Mineral Disorders in Plants Vol.1 Principles. Her Majesty's Stationery Office, London.
- Cooke GW. 1972. Fertilizers for maximizing yield. Grenada Publishing Ltd, London.
- Epstein E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. Wiley Eastern Ltd.
- Kanwar JS. 1976. Soil Fertility-Theory and Practice. ICAR, New Delhi.
- Marchner Horst. 1995. Mineral Nutrition of Higher Plants, 2nd Ed. Marschner, Academic Press Inc. San Diego, CA.
- Mengel K and Kirkby EA. 1987. Principles of Plant Nutrition. 4th Ed. International Potash Institute, Worblaufen-Bern, Switzerland.
- Prakash M. 2013. Nutritional Disorders in Fruit Crops: Diagnosis and Management. NIPA, New Delhi.
- Tandon HLS. 1992. Management of Nutrient Interactions in Agriculture. Fertilizer Development and Consultation Organization, New Delhi.
- Westerman RL. 1990. Soil Testing and Plant Analysis, 3rd Ed. Soil Science Society of America, Inc., Madison, WI.
- Yawalkar KS, Agarwal JP and Bokde S. 1972. Manures and Fertilizers. 3rd Ed. Agri Horticultural Publishing House, Nagpur.

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## **Semester-III**

**I. Course Title : Biotechnology of Fruit Crops**

**II. Course Code : FSC 509**

**III. Credit Hours : (2+1)**

**IV. Why this course ?**

In the recent times, biotechnological interventions in fruit crops have contributed in enhanced yield, biotic and abiotic stress management and improved quality traits to a considerable extent.

Hence, a course is designed to educate on the possibilities and progress made through biotechnology for improved fruit production.

#### **V. Aim of the course**

To impart knowledge on the principles and tools of biotechnology.

Structure of the course is as under:

No.	Blocks	Units
1	General Background	Introduction, History and Basic Principles
2	Tissue Culture	In-vitro Culture and Hardening
3	Genetic Manipulation	In-vitro Breeding, Transgenics and Gene Technologies

#### **VI. Theory**

##### **Block 1: General Background**

**Unit I:** Introduction, History and Basic Principles: Introduction and significance, history and basic principles, influence of explant material, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

##### **Block 2: Tissue Culture**

**Unit I:** In-vitro Culture and Hardening: Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; Organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture. Use of bioreactors and in-vitro methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues. Hardening and ex vitro establishment of tissue cultured plants.

##### **Block 3: Genetic Manipulation**

**Unit I:** In-vitro Breeding, Transgenics and Gene Technologies: Somatic cell hybridisation, construction and identification of somatic hybrids and cybrids, wide hybridization, in-vitro pollination and fertilization, haploids, in-vitro mutation, artificial seeds, cryopreservation, In-vitro selection for biotic and abiotic stress. Genetic engineering- principles and methods, transgenics in fruit crops, use of molecular markers and genomics. Gene silencing, gene tagging, gene editing, achievements of

biotechnology in fruit crops.

#### **VII. Practicals**

- An exposure to low cost, commercial and homestead tissue culture laboratories (2);
- Media preparation, Inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus (3);
- Sub-culturing techniques on anther, ovule, embryo culture, somaclonal variation (4);
- In-vitro mutant selection against abiotic stress (2);
- Protoplast culture and fusion technique (2);
- Development of protocols for mass multiplication (2);
- Project development for establishment of commercial tissue culture laboratory (1).

#### **VIII. Teaching Methods/ Activities**

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

#### **IX. Learning outcome**

After the successful completion of the course, the students are expected to know

- Basic principles and methods of plant tissue culture and other biotechnological tools.
- The use and progress of biotechnology in fruit crops.

## X. Suggested Reading

- Bajaj YPS. Eds., 1989. Biotechnology in Agriculture and Forestry. Vol. V, Fruits. Springer, USA.
- Brown TA. 2001. Gene Cloning and DNA Analysis and Introduction. Blackwell Publishing, USA.
- Chahal GS and Gosal SS. 2010. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Narosa, New Delhi.
- Chopra VL and Nasim A. 1990. Genetic Engineering and Biotechnology – Concepts, Methods and Applications. Oxford & IBH, New Delhi.
- Kale C. 2013. Genome Mapping and Molecular Breeding in Plant, Vol 4. Fruit and Nuts. Springers.
- Keshavachandran R and Peter KV. 2008. Plant Biotechnology: Tissue Culture and Gene Transfer. Orient & Longman, Universal Press, US.
- Keshavachandran R, Nazeem PA, Girija D, John PS and Peter KV. 2007. Recent Trends in Biotechnology of Horticultural Crops. Vols. I, II. NIPA, New Delhi.
- Litz RE. 2005. Biotechnology of Fruit and Nut Crops. CABI, UK.
- Miglani GS. 2016. Genetic Engineering – Principles, Procedures and Consequences. Narosa Publishing House, New Delhi.
- Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK and Mohanadas S. 2001. Biotechnology of Horticultural Crops. Vols. I–III. Naya Prokash, Kolkata.
- Peter KV. 2013. Biotechnology in Horticulture: Methods and Applications. NIPA, New Delhi.
- Vasil TK, Vasi M, While DNR and Bery HR. 1979. Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture. Platinum Press, UK.

## I. Course Title : Organic Fruit Culture

## II. Course Code : FSC 510

## III. Credit Hours : (2+1)

## IV. Why this course ?

Considering threats to environment and human health on account of excessive use of chemicals and synthetic fertilizers, organic farming is looked upon as an alternative. Though the organic and other natural farming practices are in evolving phase and are yet to be time scale tested, there is a general perception that these would hold good. As such a course is customised to educate the Graduates on

various issues related to organic farming.

## V. Aim of the course

To develop understanding on organic production of fruit crops.

The course is structured as under:-

N	Blocks	Units
1	General Aspects	Principles and Current Scenario
2	Organic Culture	Farming System and Practices
3	Certification	Inspection, Control Measures and Certification

## VI. Theory

### Block 1: General Aspects

**Unit I:** Principles and Current Scenario: Organic horticulture, scope, area, production and world trade, definition, principles, methods and SWOT analysis.

### Block 2: Organic Culture

**Unit I:** Farming System and Practices: Organic farming systems including biodynamic farming, natural farming, homa organic farming, rishi krishi, EM technology, cosmic farming; on-farm and off-farm production of organic inputs, role of bio-fertilizers, bio enhancers, legumes, inter cropping, cover crops, green manuring, zero tillage, mulching and their role in organic nutrition management.

Organic seeds and planting materials, soil health management in organic production, weed management practices in organic farming, biological management of pests and diseases, trap crops, quality improvement in organic production of fruit crops.

### **Block 3: Certification**

**Unit I:** Inspection, Control Measures and Certification: Inspection and certification of organic produce, participatory guarantee system (PGS), NPOP, documentation and control, development of internal control system (ICS), Concept of group certification, constitution of grower group as per NPOP, preparation of ICS manual, internal and external inspection, concept of third party verification, certification of small farmer groups (Group Certification), transaction certificate, group certificate, critical control points (CCP) and HACCP, IFOAM guidelines on certification scope and chain of custody, certification trademark – The Logo, accredited certification bodies under NPOP. Constraints in

certification, IFOAM and global scenario of organic movement, postharvest management of organic produce. Economics of organic fruit production.

### **VII. Practicals**

- Design of organic orchards/ farms management (1);
- Conversion plan (1);
- Nutrient management and microbial assessment of composts and bio-enhancers (2);
- Preparation and application of composts, bio-enhancers and bio-pesticides (2);
- Organic nursery raising (1);
- Application of composts, bio-enhancers, bio-fertilisers and bio-pesticides, green manure, cover, mulching (2);
- Preparation and use of neem based products (1);
- Biodynamic preparations and their role in organic agriculture, EM technology and products, biological/ natural management of pests and diseases (2);
- Soil solarisation (1);
- Frame work for GAP (1);
- Documentation for certification (1).

### **VIII. Teaching Methods/ Activities**

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

### **IX. Learning outcome**

On successful completion of the course, the students are expected to be able to

- Familiarize with the concepts and practices of organic and other natural farming systems
- Generate know-how on procedures, policies and regulation for inspection and certification of organic produce

### **X. Suggested Reading**

Claude A. 2004. The Organic Farming Sourcebook. Other India Press, Mapusa, Goa, India.

Dabholkar SA. 2001. Plenty for All. Mehta Publishing House, Pune, Maharashtra.

Das HC and Yadav AK. 2018. Advances in Organic Production of Fruit Crops. Westville Publishing House, New Delhi.

Deshpande MS. 2003. Organic Farming with respect to Cosmic Farming. Mrs. Pushpa Mohan Deshpandey, Kolhapur, Maharashtra.

Deshpande WR. 2009. Basics of Organic Farming. All India Biodynamic and Organic Farming Association, Indore. MP.

Gaur AC, Neblakantan S and Dargan KS. 1984 Organic Manures. ICAR, New Delhi.

Lampkin, N. and Ipswich, S. 1990. Organic Farming. Farming Press. London, UK.  
 Lind K, Lafer G, Schloffer K, Innershofer G and Meister H. 2003. Organic Fruit Growing. CAB International.  
 Palaniappan SP and Annadurai K. 2008. Organic Farming- Theory and Practice. Scientific Publishers, Jodhpur, Rajasthan, India.  
 Palekar S. 2004. The Technique of Spritual Farming. Chandra Smaritee, Sai Nagar, Amrawati, Maharashtra.  
 Proctor P. 2008. Biodynamic Farming and Gardening. Other India Press, Mapusa, Goa.  
 Ram RA and Pathak RK. 2017. Bioenhancers. Lap Lambert Academic Publishing, AP.

**I. Course Title : Export Oriented Fruit Production**

**II. Course Code : FSC 511**

**III. Credit Hours : (2+1)**

**IV. Why this course ?**

India is a top ranking country in production of fruit crops especially with respect mangoes, bananas, and grapes. WTO regime opens new vistas for exploring export opportunities of different fruit commodities. Already, India export mangoes, litchi, grapes, walnuts, apples, etc. and there lies a huge potential in this sector. As such a course has been developed to highlights government policies, standards, infrastructural development and export potential vis-à-vis international scenario.

**V. Aim of the course**

To acquaints with the national and international standards and export potential of fruit crops

The course is organised as under:-

<b>N</b>	<b>Blocks</b>	<b>Units</b>
1	Introduction	Statistics and World Trade
2	Regulations	Policies, Norms and Standards
3	Quality Assurance	Infrastructure and Plant Material

**VI. Theory**

**Block 1: Introduction**

**Unit I:** Statistics and World Trade: National and international fruit export and import scenario and trends; Statistics and India’s position and potentiality in world trade; export promotion zones in India. Government Policies.

**Block 2: Regulations**

**Unit I:** Policies, Norms and Standards: Scope, produce specifications, quality and safety standards for export of fruits, viz., mango, banana, grape, litchi, pomegranate, walnut, apple and other important fruits. Processed and value-added products, post harvest management for export including packaging and cool chain; HACCP, Codex alimentarius, ISO certification; WTO and its implications, sanitary and phyto-sanitary measures.

**Block 3: Quality Assurance**

**Unit I:** Infrastructure and Plant Material: Quality fruit production under protected environment; different types of structures – Automated greenhouses, glasshouse, shade net, poly tunnels – Design and development of low cost greenhouse structures. Seed and planting material; meeting export standards, implications of plant variety protection – patent regimes.

**VII. Practicals**

- Export promotion zones and export scenario of fresh fruits and their products (1);
- Practical exercises on quality standards of fruits for export purpose (2);



- Quality standards of planting material and seeds (2);
- Hi-tech nursery in fruits (1);
- Practicals on ISO specifications and HACCP for export of fruits (3);
- Sanitary and phyto-sanitary measures during export of horticultural produce (2);
- Post harvest management chain of horticultural produce for exports (2);
- Visit to export oriented units/ agencies like APEDA, NHB, etc.

### **VIII. Teaching Methods/ Activities**

- Class room Lectures
- Laboratory/ Field Practicals
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

### **IX. Learning outcome**

Consequent upon successful completion of the course, the students are expected to have learnt about

- National and international trade scenario of fruit crops
- Set norms and standards for export of fruit crops
- Requisite infrastructure and growing practices meeting export standards

### **X. Suggested Reading**

- Chadha KL. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ. House, New Delhi.
- Chetan GF. 2015. Export Prospects of Fruits and Vegetables from India: A study of Export market in EU. A project report. Anand Agricultural University, Anand, Gujarat.
- Dattatreylul M. 1997. Export potential of Fruits, Vegetables and Flowers from India. NABARD, Mumbai.
- Islam, C.N. 1990. Horticultural Export of Developing Countries: Past Preferences, Future Prospects and Policies. International Institute of Food Policy Research, USA.

### **e-Resources**

- <http://apeda.gov.in>  
<http://nhb.gov.in>  
<http://indiastat.com>

## **I. Course Title : Climate Change and Fruit Crops**

### **II. Course Code : FSC 512**

### **III. Credit Hours : (1+0)**

### **IV. Why this course ?**

In the changing climatic scenario, the fruit crops get affected adversely due to one or more unfavourable environmental factors. Shifting of temperate fruits to higher altitudes due to insufficient chilling, occurrence of drought and frost in warmer areas are notable examples. In order to educate on extent of damage and strategies to mitigate the effect of climate change, a course has been formulated.

### **V. Aim of the course**

To understand the impact of climate change and its management in fruit production.

The course is structured as under:-

<b>No.</b>	<b>Blocks</b>	<b>Units</b>
1	General Aspects	Introduction, Global Warming and Climatic

2	Climate Change and Management	Impact Assessment and Mitigation
3	Case Studies	Response to Climate Change

## VI. Theory

### Block 1: General Aspects

**Unit I:** Introduction, Global Warming and Climatic Variability: Introduction to climate change. Factors directly affecting climate change. Global warming, effect of climate change on spatio-temporal patterns of temperature and rainfall, concentrations of greenhouse gasses in atmosphere. pollution levels such as tropospheric ozone, change in climatic variability and extreme events.

### Block 2: Climate Change and Management

**Unit I:** Impact Assessment and Mitigation: Sensors for recording climatic parameters, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, longer growing seasons and shifts in plant hardiness for fruit crops. Climate mitigation measures through crop management- use of tolerant rootstocks and varieties, mulching – use of plastic- windbreak- spectral changes- protection from frost and heat waves. Climate management in

greenhouse- heating – vents – CO<sub>2</sub> injection – screens – artificial light. Impact of climate changes on invasive insect, disease, weed, fruit yield, quality and sustainability. Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems.

### Block 3: Case Studies

**Unit I:** Response to Climate Change: Case studies – responses of fruit trees to climatic variability vis-a-vis tolerance and adaptation; role of fruit tree in carbon sequestration.

## VII. Teaching Methods/ Activities

- Class room Lectures
- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

## VIII. Learning outcome

After the successful completion of the course, the students are expected to have learnt

- Nature and extent of altered behaviour or damage due to climate change
- Methods to assess the adverse effects
- Approaches to mitigate the effect due to climatic variability

## IX. Suggested Reading

Dhillon WS and Aulakh PS. 2011. Impact of Climate Change in Fruit Production. Narendra Publishing House, New Delhi.

Peter KV. 2008. Basics in Horticulture. New India Publishing Agency, New Delhi.

Ramirez F and Kallarackal J. 2015. Responses of Fruit Trees to Global Climate Change. SpringerVerlag.

Rao GSLHV. 2008. Agricultural Meteorology. Prentice Hall, New Delhi.

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

Schafeer B and Anderson P. 1994. Handbook of Environmental Physiology of Fruit Crops.Vol.1 & 2. CRC Press. USA.

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## Semester-IV

### I. Course Title : Minor Fruit Production

## II. Course Code : FSC 513

## III. Credit Hours : (2+1)

## IV. Why this course ?

Apart from commercially grown fruits, several other fruits inspite of being rich in nutrients and potential future crops, remains neglected/ underexploited. The hardy nature coupled with the possibility of diversification (newly domesticated crops) further adds to their importance. The course outlines the efforts made in standardizing agro-techniques for propagation and cultivation besides know-how on their nutraceutical value and other uses.

## V. Aim of the course

To impart basic knowledge underexploited minor fruit crops.

The course is structured as under:-

No.	Blocks	Units
1	Introduction	Occurrence, Adoption and General Account
2	Agro-Techniques	Propagation and Cultural Practices
3	Marketing and utilization	Post-Harvest Management

## VI. Learning outcome

On successful completion of the course, the students are expected to know about

- Various minor fruits hitherto neglected and their commercial value
- Efforts made to domesticate minor fruits and standardization of agro-techniques.
- Their utilization in processing industry.

## VII. Theory

### Block 1: Introduction

**Unit I:** Occurrence, Adoption and General Account: Importance – occurrence and distribution, climate adaptation in fragile ecosystem and wastelands.

### Block 2: Agro-Techniques

**Unit I:** Propagation and Cultural Practices: Traditional cultural practices and recent development in agro-techniques; propagation, botany-floral biology, growth patterns, mode of pollination, fruit set, ripening, fruit quality.

### Block 3: Marketing and Utilization

**Unit I:** Post-Harvest Management: Post harvest management, marketing; minor fruit crops in terms of medicinal and antioxidant values; their uses for edible purpose and in processing industry

### Crops

Bael, chironji, fig, passion fruit, jamun, phalsa, karonda, woodapple, cactus pear, khejri, kair, pilu, lasoda, loquat, tamarind, dragon fruit, monkey jack, mahua, khirni, amra, kokum, cape gooseberry, kaphal, persimmon, pistachio, seabuckthorn, hazel nut and other minor fruits of regional importance

## VIII. Practicals

- Visits to institutes located in the hot and cold arid regions of the country (2);
- Identification of minor fruits plants/ cultivars (2);
- Collection of leaves and preparation of herbarium (1);
- Allelopathic studies (2);
- Generating know-how on reproductive biology of minor fruits (4);
- Fruit quality attributes and biochemical analysis (3);
- Project formulation for establishing commercial orchards in fragile ecosystems (1).

## IX. Teaching Methods/ Activities

- Class room Lectures
- Laboratory/ Field Practicals

- Student Seminars/ Presentations
- Field Tours/ Demonstrations
- Assignments

#### **X. Suggested Reading**

- Ghosh SN, Singh A and Thakur A. 2017. Underutilized Fruit Crops: Importance and Cultivation. Jaya Publication House, New Delhi.
- Krishna H and Sharma RR, 2017. Fruit Production: Minor Fruits. Daya Publishing House, New Delhi.
- Mazumdar BC. 2014. Minor Fruit Crops of India: Tropical and Subtropical. Daya Publication House, New Delhi.
- Nath V, Kumar D, Pandey V and Pandey D. 2008. Fruits for the Future. Satish Serial Publishing House, New Delhi.
- Pareek OP, Sharma S, and Arora RK. 2007. Underutilised Edible Fruits and Nuts, IPGRI, Rome.
- Peter KV. 2010. Underutilized and Underexploited Horticultural Crops. NIPA, New Delhi.
- Rana JC and Verma VD. 2011. Genetic Resources of Temperate Minor Fruit (Indigenous and Exotic). NBPGR, New Delhi.
- Saroj PL and Awasthi OP. 2005. Advances in Arid Horticulture, Vol. II: Production Technology of Arid and Semiarid Fruits. IBDC, Lucknow.
- Saroj PL, Dhandar DG and Vashishta BB. 2004. Advances in Arid Horticulture, Vol.-1 Present Status. IBDC, Lucknow.
- Singh et al. 2011. Jamun. ICAR, New Delhi.