

# **SYLLABUS**

## **Course Curriculum for UG**

**(as per fifth Dean Committee)**

## **PG & Ph.D. (Fruit Science)**

**(as per new BSMA)**



**2022**

**DEPARTMENT OF FRUIT SCIENCE**

**COLLEGE OF HORTICULTURE**

**Banda University of Agriculture & Technology Banda-210001**

**Uttar Pradesh, India**

# Course Curriculum for Under Graduate

Department of fruit Science

College of horticulture

**Banda University of Agriculture and Technology, Banda**

## Courses for UG Programme College of horticulture

1	HFS 111	Fundamentals of Horticulture	3 (2+1)
2	HFS 123	Plant Propagation and Nursery Management	2 (1+1)
3	HFS 121	Tropical and Sub-Tropical Fruits	3 (2+1)
4	HFS 211	Temperate Fruit Crops	2 (1+1)
5	HFS 311	Orchard and Estate Management	2 (1+1)
6	HFS 221	Plantation Crops	3 (2+1)
8	HFS 222	Breeding of Fruit and Plantation Crops	3 (2+1)
9	HFS 223	Dryland Horticulture	2 (1+1)
10	HFS 122	Water Management in Horticultural Crops	2 (1+1)
11	HFS 212	Weed Management in Horticultural Crops	2 (1+1)

## Courses for UG Programme College of Agriculture

1.	HFS 224	Production Technology for Fruit and Plantation Crops	<b>2(1+1)</b>
2.	HFS112	Fundamentals of Horticulture	2(1+1)
3.	HFS 321	Hi tech horticulture	3(2+1)

## Courses for UG Programme College of Forestry

1	NR 111	Introduction in Agronomy and Horticulture	3(2+1)
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## SYLLABUS FOR UG PROGRAMME

### FRUIT SCIENCE

Course Code –HFS 111

Fundamentals of Horticulture

3 (2+1)

#### Theory

Scope and importance, classification of horticultural crops and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery techniques and their management, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Production and practices for fruit, vegetable and floriculture crops. Principles objectives, types and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management– irrigation methods, merits and demerits, weed management, fertility management in horticultural crops–manures and fertilizers, different methods of application, cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits, Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, principles of organic farming, market chain management.

#### Practical

Features of orchard, planning and layout of orchard, tools and implements, identification of various horticultural crops, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits, assessment of bearing habits, maturity standards, harvesting, grading, packaging and storage.

#### Suggested Reading:

- Prasad and Kumar, 2014. *Principles of Horticulture* 2<sup>nd</sup> Edn. Agrobios (India).
- Neeraj Pratap Singh, 2005. *Basic concepts of Fruit Science* 1<sup>st</sup> Edn. IBDC Publishers.
- Gardner/Bardford/Hooker. J.R., 1957. *Fundamentals of Fruit Production*. Mac Graw Hill Book Co., New York.
- Edmond,J.B, Sen,T.L, Andrews,F.S and Halfacre R.G., 1963. *Fundamentals of Horticulture*. Tata Mc Graw Hill Publishing Co., New Delhi.
- Kumar, N., 1990. *Introduction to Horticulture*. Rajyalakshmi publications, Nagarcoil, Tamilnadu
- Jitendra Singh, 2002. *Basic Horticulture*. Kalyani Publishers, Hyderabad.
- Denisen E.L.,1957. *Principles of Horticulture*. Macmillan Publishing Co., New York.
- Chadha,K.L.(ICAR),2002,2001. *HandbookofHorticulture* . ICAR, NewDelhi
- K.V.Peter, 2009. *Basics Horticulture*. New India Publishing Agency
- Kausal Kumar Misra and Rajesh Kumar, 2014. *Fundamentals of Horticulture*. Biotech Books.

### **Theory**

Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy types of dormancy (scarification & stratification) internal and external factors, nursery techniques nursery management, apomixes – mono-embryony, polyembryony, chimera & bud sport. Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons nursery (tools and implements), use of growth regulators in seed, types and stages of seed germination with examples and vegetative propagation, methods and techniques of division-stolons, pseudobulbs, offsets, runners, cutting, layering, grafting, formation of graft union, factor affecting, healing of graftage and budding physiological & bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, scion-stock relationship, and their influences, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers. Micrografting, meristem culture, callus culture, anther culture, organogenesis, somaclonal variation hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery, Cost of establishment of propagation structures.

### **Practical**

Media for propagation of plants in nursery beds, potting and repotting. Preparation of nursery beds and sowing of seeds. Raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Hardening plants in the nursery. Practicing different types of cuttings, layering, graftings and buddings including opacity and grafting, top grafting and bridge grafting etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. Digging, labelling and packing of nursery fruit plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance. Nutrient and plant protection applications during nursery.

### **Suggested Reading:**

Hudson T. Hartmann, Dale E. Kester, Fred T. Davies, Jr. and Robert L. Geneve. *Plant Propagation- Principles and Practices (7<sup>th</sup> Edition)*. PHI Learning Private Limited, New Delhi-110001

T.K.Bose, S.K.Mitra, M.K.Sadhu, P. Das and D.Sanyal. *Propagation of Tropical & Subtropical Horticultural Crops, Volume 1(3<sup>rd</sup> Revised edition)*. Naya Udyog, 206, Bidhan Sarani, Kolkata 700006.

Guy W. Adriance and Fred R. Brison. *Propagation of Horticultural Plants*. Axis Books (India).

S. Rajan and B. L. Markose (series editor Prof. K.V.Peter). *Propagation of Horticultural Crops- Horticulture Science Series vol.6*. New India Publishing Agency, Pitam Pura, New Delhi-110088.

Hartman, H.T and Kester, D.E. 1976. *Plant Propagation Principles and practices*. Prentice hall of India Pvt.Ltd., Bombay.

Sadhu, M.K. 1996. *Plant Propagation*. New age International Publishers, New Delhi.

Mukherjee, S.K. and Majumdar, P.K. 1973. Propagation of fruit crops. ICAR, New Delhi.  
 Ganner, R.J. and Choudhri, S.A. 1972. *Propagation of Tropical fruit trees*. Oxford and IBN publishing Co., New Delhi.  
 Sarma, R.R. 2002. *Propagation of Horticultural Crops*. Kalyani Publishers, (Principles and practices) New Delhi.  
 Symmonds, 1996. *Banana*. II edition Longman, London.  
 Chundawat, B.S. 1990. *Arid fruit culture*. Oxford and IBH, New Delhi.  
 Chadha, K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi.

**Course Code –HFS 121      Tropical and Sub-Tropical Fruits      3 (2+1)**

### **Theory**

Horticultural classification of fruits including genome classification. Horticultural zones of India, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops. Mango, banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael, ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian, rambutan, bilimbi, loquat, rose apple breadfruit and passion fruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures. Seediness and kokkan disease in banana, citrus decline and casual factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production.

### **Practical**

Description and identification of varieties based on flower and fruit morphology in above crops. Training and pruning of grapes, mango, guava and citrus. Selection of site and planting system, pre-treatment of banana suckers, desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Visit to commercial orchards and diagnosis of maladies. Manure and fertilizer application including bio-fertilizer in fruit crops, preparation and application of growth regulators in banana, grapes and mango. Seed production in papaya, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits. Mapping of arid and semi-arid zones of India. Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona.

### **Suggested Reading:**

H.P. Singh and M.M. Mustafa, 2009. *Banana-new innovations*. Westville Publishing House, New Delhi.  
 M.S. Ladaniya, 2013. *Citrus Fruits*. Elsevier, India post Ltd.  
 Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. *Tropical and Sub-Tropical-Vol-I*. Naya udyog-Kolkata  
 Rajput, CBS and Srihari babu, R., 1985. *Citriculture*. Kalyani Publishers, New Delhi.  
 Chundawat, B.S., 1990. *Arid fruit culture*. Oxford and IBH, New Delhi.  
 Chadha, K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi.

Symmonds, 1996. *Banana*. II Edn. Longman, London.

Radha T and Mathew L., 2007. *Fruit crops*. New India Publishing Agency.

W S Dhillon, 2013. *Fruit Production in India*. Narendra Publishing House, New Delhi

T.K.Chattopadhyay, 1997. *Text book on pomology*. Kalyani Publishers, New Delhi.

R.E.Litz, 2009. *The Mango* 2<sup>nd</sup> Edn. Cabi Publishing, Willingford, U.K.

K.L.Chadda, 2009. *Advanced in Horticulture*. Malhotra Publishing House, New Delhi.

S.P. Singh, 2004. *Commercial fruits*. Kalyani Publishers, New Delhi.

F.S. Davies and L.G.Albrigo, 2001. *Citrus*, Cab International.

## **Course Code –HFS 211    Temperate Fruit Crops            2 (1+1)**

### **Theory**

Classification of temperate fruits, detailed study of areas, production, varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage of apple, pear, peach, apricot, plum, cherry, persimmon, strawberry, kiwi, Queens land nut (Mecademia nut), almond, walnut, pecan nut, hazel nut and chest nut. Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures. Special production problems like alternate bearing problem and their remedies.

### **Practical**

Nursery management practices, description and identification of varieties of above crops, manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach and nut crops. Visit to private orchards to diagnose maladies. Working out economics for apple, pear, plum and peach.

### **Suggested Reading:**

Chattopadhyay T.K.2009.*A text book on Pomology-IV Devoted to Temperate fruits*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008

Banday F.A. and Sharma M.K.2010.*Advances in Temperate Fruit Production*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.

Kaushal Kumar Misra. 2014.*Text book of Advanced Pomology*. Biotech Books.4762-63, Ansari Road, Darya Ganj, New delhi-11002.

Das B.C and Das S. N. *Cultivation of Minor Fruits*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.

Pal J.S.2010. *Fruit Growing* .2010. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.

Mitra S.K, Rathore D.S and Bose T.K. 1992. *Temperate Fruit Crops*. Horticulture and Allied Publishers, Calcutta.

Chattopadhyay, T.K. 2000. *A Text Book on Pomology (Temperate Fruits)* Vol. IV Kalyani Publishers, Hyderabad

Chadha, T.R, 2001. *Text Book of Temperate Fruits*. Indian Council of Agricultural Research, New Delhi.

David Jackson & N E Laone, 1999 *Subtropical and Temperate Fruit Production*. CABI, Publications.

W S Dhillon. 2013. *Fruit Production In India*. Narendra Publishing House. New Delhi

**Theory**

Orchard & estate management, importance, objectives, merits and demerits, clean cultivation, sod culture, Sod mulch, herbicides and inorganic and organic mulches. Tropical, sub-tropical and temperate horticultural systems, competitive and complimentary effect of root and shoot systems. Biological efficiency of cropping systems in horticulture, systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties. Factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, Integrated nutrient and pest management. Utilization of resources constraints in existing systems. Crop model and crop regulation in relation to cropping systems. Climate aberrations and mitigation measures of Horticultural crops.

**Practical**

Layout of different systems of orchard and estate, soil management, clean, inter, cover and mixed cropping, fillers. Use of mulch materials, organic and inorganic, moisture conservation, weed control. Layout of various irrigation systems.

**Suggested Reading:**

Kumar, 1990. *Introduction to Horticulture crops*. Rajyalakshmi Publications, Nagercoil, Tamilnadu.

Palaniappan, S.P. and Sivaraman, K. 1996. *Cropping systems in the Tropics*. New age International (P) Ltd., Publishers, New Delhi.

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

WS. Dhillon and Bhatt. 2011. *Fruit Tree Physiology*. Narendra Publishing House, New Delhi.

B .C. Mazumdar. 2004. *Principles and Methods of Orchard Establishment*. Daya Publishing House, New Delhi.

T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008.

*Management of Horticultural Crops*. New India Publishing Agency, New Delhi.

B .C. Mazumdar. 2004. *Orchard Irrigation and Soil Management Practices* Daya Publishing Agency, New Delhi. Daya Publishing Agency, New Delhi.

**Theory**

History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization, soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea, Date palm and rubber.

### **Practical**

Description and identification of coconut varieties, selection of coconut and arecanut mother palm and seed nut, planting of seed nuts in nursery, layout and planting of coconut, arecanut, oil palm, cashew nut, cacao gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao. Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee, epicotyl, softwood, grafting and top working in cashew, working out the economics and project preparation for coconut, arecanut, oil palm, cashew nut, cacao, etc. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea.

### **Suggested Reading:**

Kumar, N.J.B. M. Md. Abdul Khaddar, Ranga Swamy, P. and Irrulappan, I. 1997. *Introduction to spices, Plantation crops and Aromatic plants*. Oxford & IBH, New Delhi.  
Thampan, P.K. 1981. *Hand Book of Coconut Palm*. Oxford IBH, New Delhi.  
Nair 1979. *Cashew*. CPCRI, Kerala  
Wood, GAR, 1975. *Cacao*. Longmen, London  
Ranganadhan, V. 1979. *Hand Book of Tea Cultivation*. UPASI Tea Research Station, Cinchona.  
Thompson, P.K. 1980. *Coconut*. Oxford & IBH Publishing Co. Ltd., New Delhi.

## **Course Code –HFS 212    Weed Management in Horticultural Crops    2 (1+1)**

### **Theory**

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop weed competition and allelopathy Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management; Herbicides: advantages and limitation of herbicide usage in India, Herbicide classification, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Compatibility of herbicides with other agro chemicals; Weed management in major field and horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control.

### **Practical**

Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information; Computation of herbicide doses; Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

### **Suggested reading:**

Crafts, A.S. and Robbins, W.W. 1973. *Weed Control*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.



Gupta, O.P. 1984. *Scientific Weed Management*. Today and Tomorrow Printers and Publishers, New Delhi.

Gupta, O.P. 2015. *Modern Weed Management*. Agro Bios (India), Jodhpur.

Naidu, V.S.G.R., *Handbook of Weed Identification*. Directorate of Weed Research, Jabalpur.

Rajagopal, A., Aravindan, R. and Shanmugavelu, K.G., 2015. *Weed management of Horticultural Crops*. Agrobios (India), Jodhpur.

Ramamoorthy, K. and Subbian, P., *Predominant Weed flora in hill –ecosystems*. Agrobios (India), Jodhpur.

Rao, V.S. 2000. *Principles of Weed Science*. Oxford & IBH Publishing Co., New Delhi.

Subramanian, S., Mohammed Ali, A. and Jayakumar, R. 1991. *All About Weed Control*. Kalyani Publishers, Ludhiana.

Tadulingam, C. and Venkatnarayana, D. 1955. *A Handbook of Some South Indian Weeds*. Government Press, Madras.

Thakur, C. 1977. *Weed Science*. Metropolitan Book Co. Pvt. Ltd., New Delhi.

### **Course Code –HFS 222 Breeding of Fruit and Plantation Crops 3 (2+1)**

#### **Theory**

Fruit breeding - History, importance in fruit production, distribution, domestication and adaptation of commercially important fruits, variability for economic traits, breeding strategies, clonal selection, bud mutations, mutagenesis and its application in crop improvement – policy manipulations – *in vitro* breeding tools (important fruit and plantation crops).

#### **Practical**

Exercises on floral biology, pollen viability; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy in major crops like Mango, Banana, Citrus, Grapes, Guava, Sapota, Papaya, Custard apple, Aonla, Ber, Litchi, Pomegranate, Jamun, Arecanut, Coconut, Pistachnut, Apple, Pear, Plum, Peach, Apricot and Strawberry.

#### **Suggested Reading:**

Nijar 1985. *Fruit breeding in India*, Oxford & IBH Publishing Co. New Delhi

Anil Kumar Shukla 2004. *Fruit breeding approaches & Achievements*. International Book Distributing Co. New Delhi.

Kumar, N. 1997. *Breeding of Horticultural Crops, Principles and Practices*. New India Publishing Agency, New Delhi.

Singh, B.D. 1983. *Plant Breeding Principles and methods*. Kalyani Publishers, New Delhi.

### **Course Code –HFS 223 Dryland Horticulture 2(1+1)**

#### **Theory**

Definition, importance and limitation of dry land horticulture, present status and future scope. Constraints encounter in dry lands. Agro-climatic features in rain shadow areas, scarce water resources, high temperature, soil erosion, run-off losses etc.

Techniques and management of dry land horticulture. watershed development, soil and water conservation methods-terraces, contour bunds, etc. Methods of control and impounding of run-off water-farm ponds, trenches, macro catch pits, etc., *in-situ* water harvesting methods, micro

catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, antitranspirants, growth regulators, etc. water use efficiency-need based, economic and conjunctive use of water, micro systems of irrigation etc.

Selection of plants having drought resistance. Special techniques, planting and after care-use of seedling races, root stocks, *in-situ* grafting, deep pitting/planting, canopy management etc.

Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

### **Practical**

Study of rainfall patterns. Contour bunding/trenching, micro catchments, soil erosion and its control. Study of evapotranspiration, mulches and micro irrigation systems. Special techniques of planting and aftercare in dry lands. Study of morphological and anatomical features of drought tolerant fruit crops.

### **Suggested reading:**

Chundawat, B.S. 1990. *Arid Fruit Culture*. Oxford and IBH, New Delhi.

P.L. Taroj, B.B. Vashishtha, D.G.Dhandar. 2004. *Advances in Arid Horticulture*. Internal Book Distributing Co., Lucknow.

T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Sathesan. 2008. *Management of Horticultural Crops*. New India Publishing Agency

## **College of Agriculture**

**Course Code –HFS 112 Fundamentals of Horticulture**

**2(1+1)**

### **Theory**

Horticulture - Its definition and branches, importance and scope; horticultural and botanical classification; climate and soil for horticultural crops; Plant propagation-methods and propagating structures; Seed dormancy, Seed germination, principles of orchard establishment; Principles and methods of training and pruning, juvenility and flower bud differentiation; unfruitfulness; pollination, pollinizers and pollinators; fertilization and Parthenocarpy; medicinal and aromatic plants; importance of plant bio-regulators in horticulture. Irrigation – methods, Fertilizer application in horticultural crops.

### **Practical**

Identification of garden tools. Identification of horticultural crops. Preparation of seed bed/nursery bed. Practice of sexual and asexual methods of propagation including micro-propagation. Layout and planting of orchard. Training and pruning of fruit trees. Preparation of potting mixture. Fertilizer application in different crops. Visits to commercial nurseries/orchard.

**Course Code –HFS 224, Production Technology for Fruit and Plantation Crops 2(1+1)  
2(1+1)**

**Theory**

Importance and scope of fruit and plantation crop industry in India; Importance of rootstocks; Production technologies for the cultivation of major fruits-mango, banana, citrus, grape, guava, litchi, papaya, sapota, apple, pear, peach, walnut, almond and; minor fruits- date, ber, pineapple, pomegranate, jackfruit, strawberry, plantation crops-coconut, arecanut, cashew, tea, coffee & rubber.

**Practical**

Seed propagation. Scarification and stratification of seeds. Propagation methods for fruit and plantation crops. Description and identification of fruit. Preparation of plant bio regulators and their uses, Important pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchards.

**College of Forestry**

**NR 111 Introduction to Agronomy and Horticulture 3(2+1)**

**Theory**

Agronomy, scope and its role in crop Production-Major Field crops of India – classification, area, distribution and productivity of major Field crops. Farming and cropping systems – mono, sole and multiple cropping, relay, sequential and inter cropping. Tillage- definition- objectives – types of tillage- tillage implements – tilth - characteristics of good tilth - Soil productivity and fertility- Crop nutrition – nutrients –classification – Nutrient sources- organic manures –fertilizers – biofertilizers- Integrated Nutrient Management-Importance of water in plant growth- Soil properties influencing moisture availability – texture, structure and organic matter Status-Irrigation and drainage. Weed control – definition and characteristics of weeds, classification of weeds – damages due to weeds - benefits of weeds. -Control vs prevention of weeds – methods of weed Control-Classification of herbicides–Integrated weed management. Soil and its management-Definitions and importance of horticulture- Economic importance and classification of horticultural crops and their culture and nutritive value- area and production- exports and imports- fruit, vegetables, plantation and spice crops-soil and climate–principles-planning and layout- management of orchards- planting systems and planting densities- Principles and methods of pruning and training of fruit, plantation crops- use of growth regulators in horticulture crops-Horticultural zones of state and country.

**Practical**

Identification of field crop and tillage implements. Preparation of seed beds, identification of fertilizers and manures – mixing chemical fertilizers – calculating fertilizer requirements. Identification of green manure plants. Identification of important weeds of the region with particular reference to forest plantations. Preparation of weed herbarium. Calculations of spray volume and herbicide concentrations. Methods of application of herbicides. Identification of horticultural crops-garden tools and implements. planning and layout of orchard and plantations. Digging and filling of pits for fruit and plantation crops-planting systems, training and pruning of orchard trees-preparation and application of regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits-bearing habits and maturity standards, harvesting, grading, packaging and storage.

## **Suggested reading**

- Agrawal, R.L.1980.Seed technology. Oxford & IBH Publishing.,New Delhi
- Balasubramaniyan, P and Palaniappan, S.P. 2001. Principlesand Practices of Agronomy. Agro Bios (India)Ltd.,Jodhpur.
- Bose, T.K. 1985. Fruits of India- Tropical and subtropical. Naya Prakash, Calcutta
- Brady,N.C.andWell,R.R.2002.TheNatureandPropertiesofSoils(13thed.) .Pearson Education , Delhi.
- De, G.C.1989.Fundamentals of Agronomy. Oxford &IBH Publishing Co.,New Delhi
- Havlin, J. L., Beaton, J. D., Tisdale, S.L., and Nelson, W.L. 2006. Soil Fertility and Fertilizers: An IntroductiontoNutrientManagement(7th ed.).Pearson Education, Delhi.
- ICAR.2006. Handbook of Agriculture,ICAR,NewDelhi.
- Nair,P.K.R.1979. IntensivemultiplecroppingwithcoconutsinIndia.VerlagPaulPary,Berlin
- Palaniappan, S.P. 1988. Cropping systems in the tropics - Principles and management. Wiley Eastern Limited,NewDelhi
- Randhawa,M.S.1982.HistoryofagricultureinIndia,Voll,II&III.ICAR,NewDelhi
- Reddy.T.YandReddy,G.H.S.1995.PrinciplesofAgronomy,KalyaniPublishers,Ludhiana.

## Course Curriculum for M.Sc. (Horticulture) Fruit Science

Courses	Minimum Credit Requirement
Major	20
Minor	08
Common Compulsory course	05
Basic supporting	06
Seminar	01
Research (Thesis)	30
<b>Total</b>	<b>70</b>

In addition to above, there shall be five non-credit compulsory courses as indicated below:

### Common Compulsory courses

S.N.	Course code	Course title	Credits
1.	PGS-501	Library and Information Services	0+1
2.	PGS-502	Technical Writing and Communications Skills	0+1
3.	PGS-503	Intellectual Property and its Management in Agriculture	1+0
4.	PGS-504	Basic Concepts in Laboratory Techniques	0+1
5.	PGS-505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
		<b>Total</b>	<b>5</b>

### Details of the course structure

S.N.	Course code	Course Title	Credits
<b>A. Major courses</b>			<b>20</b>
1.	FSC 501*	Tropical Fruit Production	2+1
2.	FSC 502*	Sub-Tropical and Temperate Fruit Production	2+1
3.	FSC 503*	Propagation and Nursery Management of Fruit Crops	2+1
4.	FSC 504*	Breeding of Fruit Crops	2+1
5.	FSC 505	Systematics of Fruit Crops	2+1
6.	FSC 506	Canopy Management in Fruit Crops	1+1
7.	FSC 507	Growth and Development of Fruit Crops	2+1
8.	FSC 508	Nutrition of Fruit Crops	2+1
9.	FSC 509	Biotechnology of Fruit Crops	2+1
10.	FSC 510	Organic Fruit Culture	2+1
11.	FSC 511	Export Oriented Fruit Production	2+1
12.	FSC 512	Climate Change and Fruit Crops	1+0
13.	FSC 513	Minor Fruit Production	2+1
14.	FSC 591	Seminar	0+1
15.	FSC 599	Research	0+30
<b>Basic Supporting courses</b>			<b>06 Credit</b>

\*Compulsory courses

**Students of Department of Fruit Science presently presuming minor courses in the department of Post-Harvest Technology**

**Courses for minor package in the Department of Fruit Science:** Any 8 credits out of following courses

1.	FSC 501*	Tropical Fruit Production	2+1
2.	FSC 502*	Sub-Tropical and Temperate Fruit Production	2+1
3.	FSC 503*	Propagation and Nursery Management of Fruit Crops	2+1
4.	FSC 505	Systematics of Fruit Crops	2+1
5.	FSC 506	Canopy Management in Fruit Crops	1+1

**Note:** In addition to above courses 8 credits is to be offered as minor courses from the concerned department.

### **Course allotment semester wise for M.Sc. -Fruit Science**

#### **First Semester**

S.N.	Course Code	Course Title	Credit hours
1.	FSC 502*	Sub-Tropical and Temperate Fruit Production	2+1
2.	FSC 503*	Propagation and Nursery Management of Fruit Crops	2+1
3.	FSC 506	Canopy Management in Fruit Crops	1+1
4	FSC 504*	Breeding of Fruit Crops	2+1
5	FSC 599	Research	0+5

#### **Second Semester**

S.N.	Course Code	Course Title	Credit hours
1.	FSC 501*	Tropical Fruit Production	2+1
2	FSC 505	Systematics of Fruit Crops	2+1
3	FSC 599	Research	0+5

#### **Third Semester**

S.N.	Course Code	Course Title	Credit hours
1.	FSC 507	Growth and Development of Fruit Crops	2+1
2.	FSC 591	Seminar	0+1
3	FSC 599	Research	0+5

#### **Fourth Semester**

S.N.	Course Code	Course Title	Credit hours
1.	FSC 599	Research	0+15

# **SYLLABUS OF M. Sc. FRUIT SCIENCE**

## **Common Compulsory Course (s)**

### **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.

### **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**

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

## **INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (1+0)**

### **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**

1. Erbis FH and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
2. Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
3. *Intellectual Property Rights: Key to New Wealth Generation*. 2001. NRDC and Aesthetic Technologies.
4. Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
5. Rothschild M and Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
6. Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.  
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

## **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 vascupets;
- 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**

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

## **AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (1+0)**

### **Objective**

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

### **Theory**

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

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

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

### **Suggested Readings**

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

# M.Sc. (Hort.) in Fruit Science

**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 Floor Management	I Propagation, Planting and Orchard
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.

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*. 3<sup>rd</sup> 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:

No. Blocks	Units
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 them 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



**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.

**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:**

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

## **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 cropimprovement – 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 stakeholders. 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:

No.	Blocks	Units
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 Diversity 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 chemotaxonom biochemical and molecular markers in modern systematics.

#### VII. Practical

- 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*. 3<sup>rd</sup> 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*. 2<sup>nd</sup> Edn. Elsevier.

Spencer RR, Cross R and Lumley P. 2003. *Plant Names*. 3<sup>rd</sup> 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:

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No. Blocks

Units

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- |                                |   |
|--------------------------------|---|
| 1 Canopy Architecture          | Introduction, types and Classification      |
| 2 Canopy Management regulation | 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:-

No.	Blocks	Units
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 Kriedemann PE. 1985. *Plant Growth and Development*. 3<sup>rd</sup> 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*. 4<sup>th</sup> Ed. Wadsworth Publications, USA.

Schaefer, 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, bio-fertilizers 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*, 2<sup>nd</sup> Ed. Marschner, Academic Press Inc. San Diego, CA.
- Mengel K and Kirkby EA. 1987. *Principles of Plant Nutrition*. 4<sup>th</sup> 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*, 3<sup>rd</sup> Ed. Soil Science Society of America, Inc., Madison, WI.
- Yawalkar KS, Agarwal JP and Bokde S. 1972. *Manures and Fertilizers*. 3<sup>rd</sup> Ed. Agri Horticultural Publishing House, Nagpur.

**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	<i>In-vitro</i> Culture and Hardening
3	Genetic Manipulation	<i>In-vitro</i> 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*. Springer.

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:-**

No. 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. Practical**

- 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: -

No.	Blocks	Units
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: -

No. Blocks	Units
1- General Aspects	Introduction, Global Warming and Climatic Variability
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 gases 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*. Springer- Verlag.

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.

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

**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

**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.

## Course Structure and Curriculum for Ph.D. (Horticulture) Fruit Science

Subject	Minimum Credit Requirements
Major	12
Minor	06
Basic Supporting	05
Seminar	02
Research	75
Total	100

### Details of the course structure

S.N.	Course code	Course Title	Credits
<b>Major courses</b>			
1.	FSC 601*	Innovative Approaches in Fruit Breeding	3+0
2.	FSC 602*	Modern Trends in Fruit Production	3+0
3.	FSC 603	Recent Developments in Growth Regulation	3+0
4.	FSC 604	Advanced Laboratory Techniques	1+2
5.	FSC 605	Arid and Dry Land Fruit Production	2+0
6.	FSC 606	Abiotic Stress Management in Fruit Crops	2+1
7.	FSC 607	Biodiversity and Conservation of Fruit Crops	2+1
8.	FSC 608	Smart Fruit Production	2+0
9.	FSC 691	Seminar-I	0+1
10.	FSC 692	Seminar-II	0+1
11.	FSC 699	Research	0+75
<b>Minor course</b>			06
<b>Basic Supporting courses</b>			05

\*\* Compulsory for Doctoral programme

**Students of Department of Fruit Science presently presuming minor courses in the department of Post-Harvest Technology and Department of Biochemistry.**

**Courses for minor package in the Department of Fruit Science:** Any 6 credits out of following courses

S.N.	Course code	Course Title	Credits
1	FSC602	Modern Trends in Fruit Production	3+0
2	FSC 603	Recent Developments in Growth Regulation	3+0
3	FSC601	Innovative Approaches in Fruit Breeding	3+0
4	FSC 605	Arid and Dry Land Fruit Production	2+0

## Semester wise course allotment Ph.D.-fruit Science

### First Semester

S.N.	Course Code	Course Title	Credit hours
1.	FSC 602*	Modern Trends in Fruit Production	3+0
2.	FSC 603	Recent Developments in Growth Regulation	3+0
3	FSC 601*	Innovative Approaches in Fruit Breeding	3+0
4	FSC 699	Research	0+10

**Second Semester**

S.N.	Course Code	Course Title	Credit hours
1.	FSC 605	Arid and Dry Land Fruit Production	2+0
2.	FSC 699	Research	0+10

**Third Semester**

S.N.	Course Code	Course Title	Credit hours
1.	FSC 606	Abiotic Stress Management in Fruit Crops	2+1
2	FSC 699	Research	0+10

**Fourth Semester**

S.N.	Course Code	Course Title	Credit hours
1.	FSC 691	Seminar-I	0+1
2	FSC 699	Research	0+15

**Fifth Semester**

S.N.	Course Code	Course Title	Credit hours
1.	FSC 692	Seminar-II	0+1
2	FSC 699	Research	0+15

**Sixth Semester**

S.N.	Course Code	Course Title	Credit hours
1.	FSC 699	Research	0+75
2	FSC 699	Research	0+15

# Course Contents Ph.D. (Hort.) in Fruit Science

**I. Course Title : Innovative Approaches in Fruit Breeding**

**II. Course Code : FSC 601**

**III. Credit Hours : (3+0)**

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

Modern day fruit culture witness's rapid changes in production technologies and market trends. Ever changing environment and consumer preferences warrant constant development and adoption of genetically improved varieties. There is more thrust on novelty and distinctness in view of ever increasing competition with enhanced emphasis on tailor made and trait specific designer varieties and rootstocks. The course is thus designed to integrate updated information on inherent breeding systems and innovative gene manipulation technologies enhancing breeding efficiency.

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

To update knowledge on current trends and innovative approaches in fruit breeding. The structural organization of the course is as under: -

No. Blocks	Units
1 Introduction	Current Trends and Status
2 Genetic Mechanisms	Inheritance Patterns and Breeding Systems
3 Breeding for Specific Traits	Plant Architecture, Stress Tolerance and Fruit Quality
4 Fast-Track Breeding	Transgenic, Markers and Genomics

## **VI. Theory**

### **Block 1: Introduction**

**Unit I:** Current Trends and Status: Modern trends in fruit breeding –with major emphasis on precocity, low tree volume, suitability for mechanization, health benefits, etc.

### **Block 2: Genetic Mechanisms**

**Unit I:** Inheritance Patterns and Breeding Systems: Genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits.

### **Block 3: Breeding for Specific Traits**

**Unit I:** Plant Architecture, Stress Tolerance and Fruit Quality: Recent advances in crop improvement efforts- wider adaptation, plant architecture, amenability to mechanization, fruit quality attributes, stress tolerance,

crop specific traits; use of apomixis, gene introgression and wide hybridization (alien genes).

### **Block 4: Fast-Track Breeding**



**Unit I:** Transgenic, Markers and Genomics: Molecular and transgenic approaches in improvement of selected fruit crops; fast track breeding – marker assisted selection and breeding (MAS and MAB), use of genomics and gene editing technologies.

### **Crops**

Mango, banana, guava, papaya, Citrus, grapes, pomegranate, litchi, apple, pear, strawberry, kiwifruit, plums, peaches, apricot, cherries, nectarines, nut crops

### **VII. Teaching Methods/ Activities**

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

### **VIII. Learning outcome**

- On successful completion of the course, the students are expected to Develop updated knowledge on current breeding objectives and trends
- Equip with information on innovative approaches enhancing breeding efficiency

### **IX.Suggested Reading**

Al-Khayari J, Jain SN and Johnson DV. 2018. *Advances in Plant Breeding Strategies. Vol. 3: Fruits*. Springer.

Badenes S and Byrne DH. 2012. *Fruit Breeding*. Springer.

Hancock JF. 2008. *Temperate Fruit Crop Breeding: Germplasm to Genomics*. Springer.

Kole C and Abbott AG. 2012. *Genetics, Genomics and Breeding of Stone fruits*. CRC.

Kole, C. 2011. *Wild Crops Relatives: Genomics and Breeding Resources: Tropical and Subtropical Fruits*. Springer-Verlag.

Kole C. 2011. *Wild Crops Relatives: Genomics and Breeding Resource: Temperate Fruits*. Springer-Verlag.

Jain SN and Priyadarshan PM. 2009. *Breeding Plantation and Tree Crops: Tropical Species; Temperate Species*. Springer -Verlag.

Janick J and Moore JN, 1996. *Fruit Breeding. Vols.I-III*. John Wiley & Sons, USA. Orton T. 2019. *Methods in Fruit Breeding*. Elsevier.

Singh SK, Patel VB, Goswami AK, Prakash J and Kumar C. 2019. *Breeding of Perennial Horticultural Crops*. Biotech Books. Delhi.

**I. Course Title : Modern Trends in Fruit Production**

**II. Course Code : FSC 602**

**III. Credit Hours : (3+0)**

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

Recent technological developments in propagation and cultural practices paves the way to grow fruit crops in an intensive and mechanised mode. As such a course has been developed to provide latest knowledge and updated account of modern production systems enhancing overall productivity.

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

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To keep abreast with latest developments and trends in production technologies of tropical, subtropical and temperate fruits.

No.	Blocks	Units
1	Introduction	General Concepts and Current Scenario
2	Advanced Technologies	Propagation, Planting Systems and Crop Regulation
3	Management Practices	Overcoming Stress and Integrated Approaches

## VI. Theory

### Block 1: Introduction

**Unit I:** General Concepts and Current Scenario: National and International scenario, national problems.

### Block 2: Advanced Technologies

**Unit I:** Propagation, Planting Systems and Crop Regulation: Recent advances in propagation – Troot stocks, planting systems, High density planting, crop modeling, Precision farming, decision support systems – aspects of crop regulation- physical and chemical regulation.

### Block 3: Management Practices

**Unit I:** Overcoming Stress and Integrated Approaches: Effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, Physiological disorders, Total quality management (TQM) – Current topics.

## Crops

Mango, Banana, Grapes, Citrus, Papaya, Litchi, Guava, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherry, Almond, Walnut, Pecan, Strawberry, Kiwifruit.

## 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 would have updated knowledge on current trends in fruit production.

## IX. Suggested Reading

- Bartholomew DP, Paull RE and Rohrbach KG. eds. 2002. *The Pineapple: Botany, Production, and Uses*. CAB International.
- Bose TK, Mitra SK and Sanyal D. Eds. 2002. *Fruits of India – Tropical and Sub- Tropical*. 3<sup>rd</sup> Ed. Vols. I, II. Naya Udyog, Kolkata, India.
- Dhillon WS and Bhatt ZA. 2011. *Fruit Tree Physiology*. Narendra Publishing House, New Delhi.
- Dhillon WS. 2013. *Fruit Production in India*. Narendra Publishing House, New Delhi.
- Gowen S. 1995. *Bananas and Plantains*. Chapman & Hall Publication, US.
- Litz RE. ed. 2009. *The Mango: Botany, Production and Uses*. CAB International.
- Peter KV. 2016. *Innovations in Horticulture*. NIPA, New Delhi.
- Robinson JC and Saúco VG. 2010. *Bananas and Plantains* (Vol. 19). CAB International.
- Samson JA. 1980. *Tropical Fruits*. Longman, USA.

Sharma RR and Krishna H. 2014. *Fruit Production: Major Fruits*. Daya Publishing House, Delhi.

Singh S, Shivankar VJ, Srivastava AK and Singh IP. 2004. *Advances in Citriculture*. Jagminder Book Agency, New Delhi.

Stover RH and Simmonds NW. 1991. *Bananas*. Longman, USA.

Chadha KL, Ahmed N, Singh SK and Kalia P. 2016. *Temperate Fruits and Nuts- Way Forward for Enhancing Production and Quality*. Daya Publishing House, New Delhi.

Childers NF, Morris JR and Sibbett GS. 1995. *Modern Fruit Science: Orchard and Small Fruit Culture*. Horticultural Publications, USA.

Erez A. 2013. *Temperate Fruit Crops in Warm Climates*. Springer Science.

Jackson D, Thiele G, Looney NE and Morley-Bunker M. 2011. *Temperate and Subtropical Fruit Production*. CAB International.

Ryugo K. 1998. *Fruit Culture: Its Science and Art*. John Wiley & Sons, USA.

Tromp J, Webster AS and Wertheim SJ. 2005. *Fundamentals of Temperate Zone Tree Fruit Production*. Backhuys Publishers, Lieden, The Netherlands.

Westwood MN. 2009. *Temperate Zone Pomology: Physiology and Culture*. 3<sup>rd</sup> Edn. Timber Press, USA.

**I. Course Title : Recent Developments in Growth Regulation**

**II. Course Code : FSC 603**

**III. Credit Hours : (3+0)**

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

Technological advancements have resulted in deeper understanding of growth and developmental processes in plants. There is equal and just need to apply these in fruit crops for harnessing maximum benefits in term of yield and quality. So a course has been designed to provide latest information on physiological and biochemical aspects of growth and development.

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

To develop updates on recent advances in growth regulation of fruit crops. Structure of the course is as under:

<b>No. Blocks</b>	<b>Units</b>
1 Introduction	Current Concepts and Principles
2 Growth Substances	Phytohormones and Growth Regulators
3 Growth and Development	Regulation of Developmental Processes

#### **VI. Theory**

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

**Unit I:** Current Concepts and Principles: Eco-physiological influences on growth and development of fruit crops-flowering, fruit set- Crop load and assimilate partitioning and distribution.

##### **Block 2: Growth Substances**

**Unit I:** Phytohormones and Growth Regulators: 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. Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis,

biochemical action, growth promotion and inhibition, canopy management for fertigated orchards.

### **Block 3: Growth and Development**

**Unit I:** Regulation of Developmental Processes: Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production. Flower drop and thinning, fruit-set and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation-current topics.

### **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 would have Complete understanding of growth dynamics in various fruit crops
- Know-how on manipulation of growth and development processes.

### **IX. 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, US.

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

Leopold AC and Kriedemann PE. 1985. *Plant Growth and Development*. 3<sup>rd</sup> Ed. McGraw-Hill, US.

Richard N. Artica. 1995. *Plant Growth Substances – Principles and Applications*. Chapman & Hall, USA.

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

Salisbury FB and Ross CW. 1992. *Plant Physiology*. 4<sup>th</sup> Ed. Wadsworth Publication.

**I. Course Title : Advanced Laboratory Techniques**

**II. Course Code : FSC 604**

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

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

Accurate quality analysis of edible fruit commodities warrants stringent measurement protocols besides requisite instruments/ tools and laboratory facilities. Consequently, a specialised course is designed for imparting basic and applied training on physical and biochemical assessment of the horticultural produce.

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

To familiarize with the laboratory techniques for analysis of fruit crops.

No.	Blocks	Units
1.	General Aspects	Safety Measures and Laboratory Maintenance
2.	Qualitative and Quantitative	Destructive and Non-destructive Methods
3.	Analysis Analysis	Chromatographic and microscopic Analysis and Sensory Analysis

## VI. Theory

### Block 1: General Aspects

**Unit 1:** Safety Measures and Laboratory Maintenance: Safety aspects and upkeep of laboratory, sampling procedures for quantitative analysis, determination of proximate composition of horticultural produce. Standard solutions, determination of relative water content (RWC), physiological loss in weight (PLW), calibration and standardization of instruments, textural properties of harvested produce, TSS, Specific gravity, pH and acidity.

### Block 2: Qualitative and Quantitative Analysis

**Unit I:** Destructive and Non-destructive Analysis Methods: Refractometer, spectrophotometry, non-destructive determination of colour, ascorbic acid, sugars, and starch in food crops.

**Unit II:** Chromatographic and Microscopic Analysis: Basic chromatographic techniques, GC, HPLC, GCMS, Electrophoresis techniques, ultra-filtration. Application of nuclear techniques in harvested produce. Advanced microscopic techniques, ion leakage as an index of membrane permeability, determination of biochemical components in horticultural produce.

**Unit III:** Sensory Analysis: Importance of ethylene, quantitative estimation of rate of ethylene evolution, using gas chromatograph (GC). Sensory analysis techniques, control of test rooms, products and panel.

## VII. Practical

- Determination of moisture, relative water content and physiological loss in weight (2)
- Determination of biochemical components in horticultural produce (3);
- Calibration and standardization of instruments (1);
- Textural properties of harvested produce (1);
- Determination of starch index (SI) (1);
- Specific gravity for determination of maturity assessment, and pH of produce (1)
- Detection of adulterations in fresh as well as processed products (2)
- Non-destructive determination of colour, ascorbic acid, vitamins, carotenoids, sugars and starch (2)
- Estimation of rate of ethylene evolution using gas chromatograph (GC) (2)
- Use of advanced microscopes (fluorescent, scanning electron microscope, phase contrast, etc.) (2)
- Class room Lectures
- Laboratory Practical's
- Student Seminars/ Presentations

- Field Tours/ Demonstrations
- Assignments

### IX. Learning outcome

The students would be expected to develop skills and expertise on:

- Upkeep of laboratories and handling of research instruments
- Principles and methods of various analysis

### X. Suggested Reading

AOAC International. 2003. *Official Methods of Analysis of AOAC International*. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities, USA.  
 Clifton M and Pomeranz Y. 1988. *Food Analysis-Laboratory Experiments*. AVI Publication, USA.  
 Leo ML. 2004. *Handbook of Food Analysis*. 2nd Ed. Vols. I-III, USA.  
 Linskens HF and Jackson JF. 1995. *Fruit Analysis*. Springer.  
 Pomrenz Y and Meloan CE. 1996. *Food Analysis – Theory and Practice*. CBS, USA.  
 Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw-Hill, New Delhi.  
 Thompson AK. 1995. *Post Harvest Technology of Fruits and Vegetables*. Blackwell Sciences. USA.

**I. Course Title : Arid and Dryland Fruit Production**

**II. Course Code : FSC 605**

**III. Credit Hours : (2+0)**

### IV. Why this course ?

Arid and dryland regions are known for growing an array of delicious and nutritious fruits (e.g. date palm, aonla, ber etc). Over the years, notable progress has been made in respect of domestication and technological advancements. Thus a course has been developed.

### V. Aim of the course

To keep abreast with latest developments and trends in production technology of arid and dryland fruit crops.

The course is organized as under: -

No.	Blocks	Units
1	Introduction	General Concepts and Current Scenario
2	Advanced Technologies	Propagation, Planting Systems and Crop Regulation
3	Management Practices	Stress Mitigation and Integrated Approaches

### VI. Theory

#### Block 1: Introduction

**Unit I:** General Concepts and Current Scenario: Characteristics features and major constraints of the arid and dryland region, distinguishing features of the fruit species trees

for adaptation in adapting to the region, nutritional and pharmaceutical importance, national problems.

**Unit I:** Propagation, Planting Systems and Crop Regulation: Recent advances in propagation – root stocks, planting systems, High density planting, crop modelling, Precision farming, decision support systems – aspects of crop regulation- physical and chemical regulation, effects on physiology and development, influence of stress factors.

### **Block 3: Management Practices**

**Unit I:** Stress Mitigation and Integrated Approaches: Strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, total quality management (TQM) – Current topics.

### **Crops**

Aonla, Annonas, ber, bael, jamun, date palm, cactus pear, khejri, kair, pilu, lasoda, manila, tamarind, monkey jack, mahua, khirni, amra, seabuckthorn, chilgoza, cafel, rhododendron, box myrtle, chironji, phalsa, karonda, woodapple, paniala and other minor fruits of regional importance

### **VII. Teaching Methods/ Activities**

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

### **VIII. Learning outcome**

- Consequent upon successful completion of the course, the students are expected to learnt about
- Fruit crops adopting to arid and drylands and their features
- Specific cultivation and management practices

### **IX. Suggested Reading**

- Hiwale S. 2015. *Sustainable Horticulture in Semiarid Drylands*. Springer.
- Krishna H and Sharma RR. 2017. *Fruit Production – Minor Fruits*. Daya Publishing House, Delhi.
- More T A, Singh RS, Bhargava R and Sharma BD. 2012. *Arid Horticulture for Nutrition and Livelihood*. Agrotech Publishing Academy, Udaipur (Rajasthan).
- Pareek OP, Sharma S and Arora RK. 2007. *Underutilised Edible Fruits and Nuts*, IPGRI, Rome.
- Peter K.V. 2010. *Underutilized and Underexploited Horticultural Crops*. NIPA, New Delhi.
- Saroj PL, Dhandar DG and Vashishta BB. 2004. *Advances in Arid Horticulture, Vol.- 1 Present Status*. IBDC, Lucknow.
- Saroj P L and Awasthi OP. 2005. *Advances in Arid Horticulture, Vol: II: Production Technology of Arid and Semiarid Fruits*. IBDC, Lucknow.
- Sontakke MB. 2014. *Production and Management of Fruit crops in Arid/ Drylands*. Agrotech Publishing Academy, Udaipur (Rajasthan).



**I. Course Title : Abiotic Stress Management in Fruit Crops**

**II. Course Code : FSC 606**

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

**IV. Why this course?**

Low soil fertility coupled with unpredictable and unfavorable environments often result in stress conditions. Non-availability of optimum level of inputs and congenial

weather necessitates the development of suitable management practices to overcome various abiotic stresses. Hence a course is customized.

**V. Aim of the course**

To update knowledge on recent trends in management of abiotic stresses in fruit crops.

The course is organized as follows:

No. Blocks	Units
1 Introduction	Basic Aspects and Principles
2 Stress Impact	Assessment, Physiology and Performance
3 Stress Management	Mitigation Measures and Conservation Practices

**VI. Theory**

**Block 1: Introduction**

**Unit I:** Basic Aspects and Principles: 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.). Pollution – increased level of CO<sub>2</sub>, industrial wastes, impact of stress in fruit crop production, stress indices, physiological and biochemical factors associated with stress, fruit crops suitable for different stress situations.

**Block 2: Stress Impact**

**Unit I:** Assessment, Physiology and Performance: Crop modeling for stress situations, cropping systems, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity.

**Block 3: Stress Management**

**Unit I:** Mitigation Measures and Conservation Practices: Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti-transparent and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers. Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, stability and sustainability indices.

**VII. Practical**

- Seed treatment/ hardening practices (2);
- Container seedling production (2);
- Analysis of soil moisture estimates (FC, ASM, PWP) (1);



- 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 (5);
- Biological efficiencies, WUE, solar energy conversion and efficiency (2);
- Crop growth sustainability indices and economics of stress management (2);
- Visit to orchards and watershed locations (2);

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

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

### **XI. Learning outcome**

- On successful completion of the course, the students are expected to generate know-how on Various types of abiotic stresses and their effects
- Physiological processes underlying abiotic stresses
- Management and conservation practices to overcome stress

### **X. Suggested Reading**

Blumm A. 1988. *Plant Breeding for Stress Environments*. CRC Publication, USA. Christiansen, MN and Lewis CF. 1982. *Breeding Plants for Less Favourable Environments*. Wiley International Science, USA.

Kanayama Y and Kochetor. 2015. *Abiotic Stress Biology in Horticultural Plants*. Springer.

Kramer PJ. 1980. *Drought Stress and the Origin of Adaptation*. In: *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons, USA.

Maloo SR. 2003. *Abiotic Stress and Crop Productivity*. Agrotech Publ. Academy, India.

Nickell LG. 1983. *Plant Growth Regulating Chemicals*. CRC Publication, USA.

Rao NKS, Shivashankar KS and LaXman RH. 2016. *Abiotic Stress Physiology of Horticultural Crops*. Springer.

Turner NC and Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons, USA.

**I. Course Title : Biodiversity and Conservation of Fruit Crops**

**II. Course Code : FSC 607**

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

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

The availability of pertinent gene pool is of utmost importance to mitigate adverse climate and to counter diseases and pests. In addition, specific gene sources (germplasm) would always be a necessity to develop superior genotypes. Considering the importance of conserving biodiversity in fruit crops for future use, the course has been designed.

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

To understand the status and magnitude of biodiversity and strategies in germplasm conservation of fruit crops.

The course is organized as follows:-

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**No. Blocks****Units**

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1	General Aspects	Issues, Goals and Current Status
2	Germplasm	Conservation Collection, Maintenance and Characterization
3	Regulatory Horticulture	Germplasm EXchange, Quarantine and Intellectual Property Rights

**VI. Theory****Block 1: General Aspects**

**Unit I:** Issues, Goals and Current Status: Biodiversity and conservation; issues and goals- needs and challenges; present status of gene centres; world's major centres of fruit crop domestication; current status of germplasm availability/ database of fruit crops in India.

**Block 2: Germplasm Conservation**

**Unit I:** Collection, Maintenance and Characterization: Exploration and collection of germplasm; sampling frequencies; size and forms of fruit and nut germplasm collections; active and base collections. Germplasm conservation- *in situ* and *ex situ* strategies, on farm conservation; problem of recalcitrancy- cold storage of scions, tissue culture, cryopreservation, pollen and seed storage.

**Block 3: Regulatory Horticulture**

**Unit I:** Germplasm EXchange, Quarantine and Intellectual Property Rights: Regulatory horticulture, inventory and EXchange of fruit and nut germplasm, plant quarantine, phyto-sanitary certification, detection of genetic constitution of germplasm and maintenance of core collection. IPRs, Breeder's rights, Farmer's rights, PPV and FR Act. GIS and documentation of local biodiversity, Geographical indications, GIS application in horticultural mapping and spatial analyses of field data; benefits of GI protection; GI tagged fruit varieties in India.

**Practical**

- Documentation of germplasm- maintenance of passport data and other records of accessions (2);
- Field exploration trips and sampling procedures (2);
- Exercise on *ex situ* conservation – cold storage, pollen/ seed storage (2);
- Cryopreservation (2);
- Visits to National Gene Bank and other centers of PGR activities (2);
- Detection of genetic constitution of germplasm (2);
- Germplasm characterization using a standardised DUS test protocol (2);
- Special tests with biochemical and molecular markers (2).

**VIII. Teaching Methods/ Activities**

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

**IX. Learning outcome**

The student would be expected to learn about the significance of germplasm and various strategies to conserve it in the present context.

## X. Suggested Reading

- Dhillon BS, Tyagi RK, Lal A and Saxena S. 2004. *Plant Genetic Resource Management. – Horticultural Crops*. Narosa Publishing House, New Delhi.
- Engles JM, Ramanath RV, Brown AHD and Jackson MT. 2002. *Managing Plant Genetic Resources*, CABI, Wallingford, UK.
- Frankel OH and Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow*. Cambridge University Press, USA.
- Hancock J. 2012. *Plant Evolution and the Origin of Crops Species*. CAB International.
- Jackson M, Ford-Lloyd B and Parry M. 2014. *Plant Genetic Resources and Climate Change*. CABI, Wallingford, UK.
- Moore JN and Ballington Jr, JR. 1991. *Genetic Resources of Temperate Fruit and Nut Crops*. ISHS, Belgium.
- Peter KV. 2008. *Biodiversity of Horticultural Crops*. Vol. II. Daya Publ. House, Delhi.
- Peter KV. 2011. *Biodiversity in Horticultural Crops*. Vol.III. Daya Publ. House, Delhi.
- Rana JC and Verma VD. 2011. *Genetic Resources of Temperate Minor Fruits (Indigenous and Exotic)*. NBPGR, New Delhi.
- Rajasekharan PE, Rao V and Ramanatha V. 2019. *Conservation and Utilization of Horticultural Genetic Resources*. Springer.
- Sthapit B, et al. 2016. *Tropical Fruit Tree Diversity (Good Practices for in situ and ex situ conservation)*. Bioversity International. Routledge, Taylor and Francis Group.
- Virchow D. 2012. *Conservation of Genetic Resources*, Springer Verlag, Berlin.

**I. Course Title : Smart Fruit Production**

**II. Course Code : FSC 608**

**III. Credit Hours : (2+0)**

### IV. Why this course?

In the era of automation and mechanization, several recent innovations have direct applications in fruit growing. Thus a need is felt to have course on smart innovations.

### V. Aim of the course

To acquire knowledge on hi-tech innovations useful in fruit crops.

The course is structure is as under:

No. Blocks	Units
1 Introduction	Importance and Overview
2 Crop Modelling and Forecasting	GIS, Sensors and Wireless System
3 Nanotechnology	Concepts and Methods Innovative Approaches Mechanization, Automation

### VI. Theory

#### Block 1: Introduction

**Unit I:** Importance and Overview: Introduction and importance; concepts and applications of artificial intelligence systems; case studies in horticulture

#### Block 2: Crop Modelling and Forecasting

**Unit I:** GIS, Sensors and Wireless Systems: Application of sensors in fruit production, crop monitoring – crop load and stress incidence forecast modules, remote sensing, Geographical Information System (GIS), Differential Geo-Positioning System (DGPS) hi-tech nursery production of fruit crops under protected conditions, ultra-modern wireless based drip irrigation network.

### **Block 3: Nanotechnology**

**Unit I:** Concepts and Methods: Nanotechnology for smart nutrient delivery in fruit farming, concepts and methods, practical utility, nano-fertilizers, nano-herbicides; nano-pesticides

### **Block 4: Innovative Approaches**

**Unit I:** Mechanization, Automation and Robotics: Production systems amenable to automation and mechanization; automated protected structures (tunnel key systems); hydroponics, aeroponics, bioreactors for large scale plant multiplication; Use of drones and robotics in fruit growing – robotic planters, sprayers, shakers, harvesters, stackers, etc. Visit to Hi-tech facilities.

## **VII. Teaching Methods/ Activities**

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

## **VIII. Learning outcome**

After successful completion of the course, the students are expected to learn about latest innovations in automation, nanotechnology and robotics for realizing smart fruit production.

## **IX. Suggested Reading**

Chadha *et al.* 2017. *Doubling Farmers' Incomes through Horticulture*. Daya Publishing House, New Delhi.

Chadha *et al.* 2019. *Shaping the Future of Horticulture*. Kruger Brentt Publishers, UK.  
Hewett EW. 2013. *Automation, Mechanization and Robotics in Horticulture*. In: Workshop on Emerging Postharvest Technologies. UC, Davis, USA.  
Peter KV. 2016. *Innovations in Horticulture*. NIPA, New Delhi.

Prasad S, Singh D and Bhardwaj RL. 2012. *Hi-Tech Horticulture*. Agro-bios (India). Tyagi, S. 2019. *Hi- Tech Horticulture*. Vols. 1 to 7. NIPA, New Delhi.

Zhang Q. 2017. *Automation in Tree Fruit production – Principles and Practice*. CABI. <http://horticulture.ucdavis.edu>- Innovative Technology for Horticultural Department.

## **Selected Journals**

Sr. No.	Name of the Journal	ISSN No.
1.	<i>Advances in Horticultural Science</i>	0394-6169
2.	<i>Acta Horticulture</i>	0567-7572
3.	<i>American Journal of Enology and Viticulture</i>	0002-9254
4.	<i>Annals of Arid Zone</i>	0570-1791
5.	<i>Annals of Horticulture</i>	0974-8784

<b>6.</b>	<i>Biodiversity and Conservation</i>	0960-3115
<b>7.</b>	<i>Current Horticulture</i>	2347-7377
<b>8.</b>	<i>European Journal of Horticultural Science (Gartenbauwissenschaft)</i>	1611-4426
<b>9.</b>	<i>Fruits</i>	0248-1294
<b>10.</b>	<i>Genetic Resources and Crop Evolution</i>	0925-9864
<b>11.</b>	<i>Horticultural Plant Journal</i>	2488-0141
<b>12.</b>	<i>Horticulture Environment and Biotechnology</i>	2211-3452
<b>13.</b>	<i>Hort Science</i>	0018-5345
<b>14.</b>	<i>Indian Horticulture Journal</i>	2249-6823
<b>15.</b>	<i>Indian Journal of Arid Horticulture</i>	Naas-1234
<b>16.</b>	<i>Indian Journal of Dryland Agricultural Research and Development</i>	0971-2062