



**Department of Horticulture
Mahatma Phule Krishi Vidyapeeth
Rahuri-413 722, Dist. Ahmednagar (MS)**



Master's Programme in Fruit Science

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit (s)
1.	Major	20
2.	Minor	09
3.	Supporting	06
4.	Seminar	01
5.	Research	20
	Total Credits	56
6.	Compulsory Non Credit Courses	04

Sr. No.	Course Number	Course Title	Credits
A) Major Subjects (Min. 20 credits)			
1	FSC - 501*	Tropical and Dry Land Fruit Production	2+1=3
2	FSC - 502*	Subtropical and Temperate Fruit Production	2+1=3
3	FSC - 503	Biodiversity and Conservation of Fruit Crops	2+1=3
4	FSC - 506*	Breeding of Fruit Crops	2+1=3
5	FSC - 507	Post Harvest Technology for Fruit Crops	2+1=3
6	FSC - 508	Growth and Development of Horticultural Crops	2+1=3
7	FSC - 510	Organic Horticulture	1+1=2

B) Minor Subjects (Min. 09 credits)			
1	AGRO - 505	Agro-Meteorology and Crop Weather Forecasting	2+1=3
2	BIOCHEM - 501	Basic Biochemistry	2+1=3
3	GP - 510	Breeding for Biotic and Abiotic Stress Resistance	2+1=3
C) Supporting Subjects (Min. 06 credits)			
1	STAT - 511	Statistical Methods for Applied Science	2+1=3
2	STAT - 512	Experimental Designs	2+1=3
D) Seminar (01 credit)			
1	FSC - 591	Seminar	0+1=1
E) Master's Research (20 credits)			
1		Master's Research	0+20=20
F) Non Credit Compulsory Courses			
1	PGS - 501	Library and information services	0+1=1
2	PGS - 504	Basic concepts in Laboratory Techniques	0+1=1
3	PGS - 502	Technical Writing and Communication Skill	0+1=1
4	PGS - 503	Intellectual Property and its Management in Agriculture	1+0=1

Course Contents

A) Major Subjects:

Course No.	: FSC 501
Course Title	: TROPICAL AND DRY LAND FRUIT PRODUCTION
Credits	: 2+1 = 3

Theory:

Commercial varieties of regional, national and international importance. Ecophysiological requirements, recent trends in propagation. Rootstock influence, planting systems, cropping systems. Root zone and canopy management. Nutrient management, water management, fertigation, Role of bio-regulators. Abiotic factors limiting fruit production. Physiology of flowering, pollination, fruit set and development, honeybees in cross pollination. Physiological disorders-causes and remedies. Quality improvement by management practices. Maturity indices, harvesting, grading, packing, storage and ripening techniques. Industrial and export potential, Agri. Export Zones (AEZ) and industrial supports of following crops.

Unit-I: Mango, Banana

Unit-II: Cashewnut, Papaya

Unit-III: Guava, Sapota, Jackfruit

Unit-IV: Pineapple, Annonas, Avocado

Unit-V: Aonla, Tamarind, Ber and Minor fruits of tropics

Practical:

Identification of important cultivars. Identification of important cultivars. Use of plant growth regulators for growth and flowering. Studies on malady diagnosis. Analysis of quality attributes (physical and chemical). Visit to tropical and arid zone orchards. Role of NHM, Project preparation for establishing commercial orchards (any one crop).

Practical No.	Topic
1-3	Identification of important cultivars.
4-6	Observations on growth and development (Mango, banana, cashew nut).
7	Use of plant growth regulators for growth and flowering.
8	Studies on malady diagnosis.
9-10	Analysis of quality attributes (physical and chemical).
11-13	Visit to tropical and arid zone orchards.
14	Role of NHM
15-16	Project preparation for establishing commercial orchards (any one crop).

Reference Books:

- Bose, T.K, Mitra, S.K & Rathore, D.S. (Eds.). 1988. Temperate Fruits - Horticulture. Allied Publ.
- Bose, T.K, Mitra, S.K & Sanyal, D. 2001. (Eds.). Fruits -Tropical and Subtropical. Naya Udyog.
- Chadha, K.L & Pareek, O.P. 1996. (Eds.). Advances in Horticulture. Vols. II-IV. Malhotra Publ. House.
- Nakasone, H.Y & Paul, R.E. 1998. Tropical Fruits. CABI.
- Peter, K.V. 2008. (Ed.). Basics of Horticulture. New India Publ. Agency.
- Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. Management of Horticultural Crops. Parts I, II. New India Publ. Agency.
- Radha, T & Mathew, L. 2007. Fruit Crops. New India Publ. Agency.
- Singh, H.P, Negi, J.P & Samuel JC. (Eds.). 2002. Approaches for Sustainable Development of Horticulture. National Horticultural Board.
- Singh, H.P, Singh, G, Samuel, J.C & Pathak, R.K. (Eds.). 2003. Precision Farming in Horticulture. NCPAH, DAC/PFDC, CISH, Lucknow.

Course No.	: FSC 502
Course Title	: SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION
Credits	: 2+1=3

Theory:

Commercial varieties of regional, national and international importance. Ecophysiological requirements, recent trends in propagation. Rootstock influence, planting systems, cropping systems. Root zone and canopy management. Nutrient management, water management, fertigation. Bio-regulation, abiotic factors limiting fruit production, Physiology of flowering, fruit set and development, abiotic factors limiting production, Physiological disorders-causes and remedies, Quality improvement by management practices. Maturity indices, harvesting, grading, packing, pre-cooling, storage, transportation and ripening techniques; Industrial and export potential, Agri Export Zones (AEZ) and industrial support of following crops.

Unit-I	Apple, pear, grapes
Unit-II	Plums, peach, apricot, cherries, hazlenut
Unit-III	Litchi, loquat, persimon, kiwifruit, strawberry
Unit-IV	Nuts- walnut, almond, citrus, fig, jamun, pomegranate
Unit-V	Minor fruits- mangosteen, carambola, bael, wood apple

Practical:

Identification of important cultivars, Observations on growth and development (Any three crops), Use of plant growth regulators for growth and flowering, Studies on malady diagnosis, Analyses of quality attributes (physical and chemical), Visit to sub-tropical, humid sub-tropical and temperate orchards, Project preparation for establishing commercial orchards (any one crop).

Practical No.	Topic
1-3	Identification of important cultivars.
4-6	Observations on growth and development (Any three crops).
7	Use of plant growth regulators for growth and flowering.
8	Studies on malady diagnosis.
9-10	Analyses of quality attributes (physical and chemical).
11-14	Visit to sub-tropical, humid sub-tropical and temperate orchards.
15-16	Project preparation for establishing commercial orchards (any one crop).

Reference Books:

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

Course No.	:	FSC 503
Course title	:	BIODIVERSITY AND CONSERVATION OF FRUIT CROPS
Credits	:	2+1=3

Theory:

Unit-I	:	Biodiversity and conservation; issues and goals, Centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.
Unit-II	:	Present status of gene centers. Exploration and collection of germplasm. Conservation of genetic resources-conservation in situ and ex-situ.
Unit-III	:	Germplasm conservation- problem of recalcitrancy. Cold storage of scions, tissue culture, cryopreservation. Pollen and seed storage; inventory of germplasm. Introduction of germplasm, plant quarantine.
Unit-IV	:	Intellectual property rights, Regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.
Unit-V	:	GIS and documentation of local biodiversity, Geographical indication.
Crops:		Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus, Prunus sp, litchi, nuts, coffee, tea, cashew, coconut, cocoa, arecanut and betelvine.

Practical:

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips (Minimum 3 crops). Exercise on ex situ conservation – cold storage, pollen/seed storage, cryo-preservation. Visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling. Germplasm characterization using molecular techniques.

Practical No.	Topic
1-3	Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips (Minimum 3 crops).
4-7	Exercise on ex situ conservation – cold storage, pollen/seed storage, cryopreservation.
8-10	Visits to National Gene Bank and other centers of PGR activities.
11-13	Detection of genetic constitution of germplasm, core sampling.
14-16	Germplasm characterization using molecular techniques.

Reference Books:

Frankel OH & Hawkes JG. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.

Peter KV & Abraham Z. 2007. Biodiversity in Horticultural Crops. Vol. I. Daya Publ. House.

Peter KV. 2008. Biodiversity of Horticultural Crops. Vol. II. Daya Publ. House.

Course No. : FSC 505

Course title : PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS

Credits : 2+1=3

Theory:

Unit-I	:	Introduction, life cycles in plants, cellular basis for propagation. Sexual propagation, apomixis, polyembryony, chimeras. Principle factors influencing seed germination of horticultural crops, dormancy. Hormonal regulation of germination and seedling growth.
Unit-II	:	Seed quality, treatment, packing, storage, certification, testing. Asexual propagation- rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods
Unit-III	:	Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working. Progeny orchard and scion bank.
Unit-IV	:	Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - in vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.
Unit-V	:	Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Nursery act.

Practical:

Anatomical studies in rooting of cutting and graft union. Construction of propagation structures, study of media and PGR. Hardening – case studies, micropropagation, explant preparation. Media preparation, culturing – *in vitro* clonal propagation. Meristem culture, shoot tip culture, axillary bud culture. Direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening. Visit to TC labs and nurseries.

Practical No.	Topic
1-2	Anatomical studies in rooting of cutting and graft union.
3-4	Construction of propagation structures, study of media and PGR.
5-6	Hardening – case studies, micro-propagation, explant preparation.
7-8	Media preparation, culturing – <i>in vitro</i> clonal propagation.
9-10	Meristem culture, shoot tip culture, axillary bud culture.
11-13	Direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening.
14-16	Visit to TC labs and nurseries.

Reference Books:

Hartmann, H.T & Kester, D.E. 1989. Plant Propagation – Principles and Practices. Prentice Hall of India.
Bose, T. K, Mitra, S.K & Sadhu, M.K. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash.
Peter. K. V. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency.
Singh S. P. 1989 Mist Propagation. Metropolitan Book Co.
Rajan, S. & Baby, L.M. 2007. Propagation of Horticultural Crops. New India Publ. Agency.
Radha, T. & Mathew, L. 2007. Fruit Crops. New India Publ. Agency.

Course No.	: FSC 506
Course title	: BREEDING OF FRUIT CROPS
Credits	: 2+1=3

Theory:

Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement -introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.
Unit-I: Mango, banana and pineapple
Unit-II: Citrus, grapes, guava and sapota
Unit-III: Jackfruit, papaya, custard apple, aonla and ber
Unit-IV: Pomegranate, litchi, jamun, mulberry, bael, kokam and cashewnut
Unit-V: Apple, pear, plums, peach, apricot, cherries and strawberry

Practical:

Characterization of germplasm. Blossom biology and study of anthesis. Estimating fertility status, practices in hybridization. Use of chemicals for induction of polyploidy. Use of physical and chemical mutant for induction of mutation. Evaluation of biometrical traits and quality traits. Screening of germplasm for resistance. Developing breeding programme for specific traits. Visit to research stations working on tropical, subtropical and temperate fruit improvement.	
Practical No.	Topic
1	Characterization of germplasm.
2-3	Blossom biology and study of anthesis.
4-5	Estimating fertility status, practices in hybridization.
6	Use of chemicals for induction of polyploidy.
7	Use of physical and chemical mutant for induction of mutation.
8-10	Evaluation of biometrical traits and quality traits.
11-12	Screening of germplasm for resistance.
13-14	Developing breeding programme for specific traits.
15-16	Visit to research stations working on tropical, subtropical and temperate fruit improvement

Reference Books:

<p>Bose TK, Mitra SK & Sanyol D. (Eds.). 2002. Fruits of India – Tropical and Sub-tropical. 3rd Ed. Vols. I, II. Naya Udyog.</p> <p>Chadha KL & Pareek OP. 1996. (Eds.). Advances in Horticulture. Vol. I. Malhotra Publ. House.</p> <p>Chadha KL & Shikhamany SD. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.</p> <p>Janick J & Moore JN. 1996. Fruit Breeding. Vols. I-III. John Wiley & Sons.</p> <p>Nijjar GS. 1977. (Eds.). Fruit Breeding in India. Oxford & IBH.</p> <p>Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.</p> <p>Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. Advances in Citriculture. Jagminder Book Agency.</p>
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Course No. : FSC 507
Course Title : POST HARVEST TECHNOLOGY FOR FRUIT CROPS
Credits : 2+1=3

Theory:

Unit-I	:	Maturity indices, harvesting practices for specific market requirements. Influence of pre-harvest practices. Enzymatic and textural changes. Respiration, transpiration.
Unit-II	:	Physiology and biochemistry of fruit ripening. Ethylene evolution and ethylene management. Factors leading to post-harvest loss. Pre-cooling.
Unit-III	:	Treatments prior to shipment, viz., chlorination, waxing, chemicals. Biocontrol agents and natural plant products. Methods of storage-ventilated, refrigerated, MAS, CA storage. Physical injuries and disorders.
Unit-IV	:	Packing methods and transport. Principles and methods of preservation. Fruit processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.
Unit-V	:	Dried and dehydrated products. Nutritionally enriched products. Fermented fruit beverages, packaging technology. Processing waste management, food safety standards.

Practical:

Analyzing maturity stages of commercially important horticultural crops. Improved packing and storage of important horticultural commodities. Physiological loss in weight of fruits, estimation of transpiration, respiration rate, ethylene release. Studies on shelf life, extension and storage life by chemicals. Estimation of quality characteristics in stored fruits, cold chain management Visit to cold storage and CA storage units. Visit to fruit processing units, Project preparation and evaluation of processed horticultural products (Any one).

Practical No.	Topic
1-2	Analyzing maturity stages of commercially important horticultural crops.
3-4	Improved packing and storage of important horticultural commodities.
5-6	Physiological loss in weight of fruits, estimation of transpiration, respiration rate, ethylene release.
7-8	Studies on shelf life, extension and storage life by chemicals.
9-10	Estimation of quality characteristics in stored fruits, cold chain, management
11-12	Visit to cold storage and CA storage units.
13-14	Visit to fruit processing units
15-16	Project preparation, evaluation of processed horticultural products (any one)

Reference Books:

Bhutani RC. 2003. Fruit and Vegetable Preservation. Biotech Books.
Chadha KL & Pareek OP. (Eds.). 1996 Advances in Horticulture. Vol. IV. Malhotra Publ. House.
Haid NF & Salunkhe SK. 1997. Post Harvest Physiology and Handling of Fruits and Vegetables. Grenada Publ.
Mitra SK. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CABI.
Ranganna S. 1997. Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill.
Sudheer KP & Indira V. 2007. Post Harvest Technology of Horticultural Crops. New India Publ. Agency.
Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals. CABI.

Course No.	: FSC 508
Course title	: GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS
Credits	: 2+1=3

Theory:

Unit-I	: Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.
Unit-II	: Annual, semi-perennial and perennial horticultural crops. Environmental impact on growth and development. Effect of light, photosynthesis, photoperiodism and vernalisation. Effect of temperature, heat units, thermoperiodism.
Unit-III	: Assimilate partitioning during growth and development. Influence of water and mineral nutrition during growth and development. Biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brassino-steroids, growth inhibitors, morphactins. Role of plant growth promoters and inhibitors.
Unit-IV	: Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.
Unit-V	: Growth and developmental process during stress – manipulation of growth and development. Impact of pruning and training. Chemical manipulations in horticultural crops. Molecular and genetic approaches in plant growth development.

Practical:

Understanding dormancy mechanisms in seeds, tubers and bulbs. Stratification of seeds, tubers and bulbs. Visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns. Techniques of growth analysis. Evaluation of photosynthetic efficiency under different environments. Study of growth regulator functions, hormone assays, understanding ripening phenomenon in fruits and vegetables. Study of impact of physical manipulations on growth and development. Study of chemical manipulations on growth and development, understanding stress impact on growth and development.	
Practical No.	Topic
1-2	Understanding dormancy mechanisms in seeds, tubers and bulbs.
3-4	Stratification of seeds, tubers and bulbs.
5-6	Visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns.
7-8	Techniques of growth analysis.
9	Evaluation of photosynthetic efficiency under different environments.
10-12	Study of growth regulator functions, hormone assays, understanding ripening phenomenon in fruits and vegetables.
13-14	Study of impact of physical manipulations on growth and development.
15-16	Study of chemical manipulations on growth and development, understanding stress impact on growth and development.

Reference Books:

<p>Buchanan B, Gruissam W & Jones R. 2002. Biochemistry & Molecular Biology of Plants. John Wiley & Sons.</p> <p>Epstein E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. Wiley.</p> <p>Fosket DE. 1994. Plant Growth and Development: a Molecular Approach. Academic Press.</p> <p>Leopold AC & Kriedermann PE. 1985. Plant Growth and Development. 3rd Ed. Mc Graw-Hill.</p> <p>Peter KV. 2008. (Ed.) Basics of Horticulture. New India Publ. Agency.</p> <p>Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: Plants (I. Ridge, Ed.), pp. 221-274, Oxford University Press.</p> <p>Salisbury FB & Ross CW. 1992. Plant Physiology. 4th Ed. Wadsworth Publ.</p>

Course No. : FSC 510
Course title : ORGANIC HORTICULTURE
Credits : 1+1=2

Theory:

Unit-I	:	Organic horticulture – definition, synonyms and misnomers, principles, methods, merits and demerits.
Unit-II	:	Organic farming systems, Different organic inputs, their role in organic horticulture, Role of biofertilizers, biodynamics and the recent developments.
Unit-III	:	EM technology and its impact in organic horticulture. Indigenous practices of organic farming, Sustainable soil fertility management, Weed management practices in organic farming, Biological/natural control of pests and diseases, Organic horticulture in quality improvement.
Unit-IV	:	GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.
Unit-V	:	Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, Post-harvest management of organic produce.

Practical:

Features of organic orchards, working out conversion plan. Input analysis- manures, nutrient status assessment of manures, bio-composting. Biofertilizers and their application. *Panchagavya* preparation and other organic nutrients application. Methods of preparation of compost, vermicompost, green manuring. Preparation of neem products and application. BD preparations and their role. EM technology and products. Biological/natural control of pests and diseases. Soil solarization. Frame work for GAP, case studies. HACCP analysis, residue analysis in organic products. Documentation for certification. Visit to fields cultivated under organic practices.

Practical No.	Topic
1	Features of organic orchards, working out conversion plan.
2	Input analysis- manures, nutrient status assessment of manures, bio-composting.
3	Biofertilizers and their application.
4	<i>Panchagavya</i> preparation and other organic nutrients application.
5-6	Methods of preparation of compost, vermin-compost, green manuring.
7	Preparation of neem products and application.

8	BD preparations and their role.
9	EM technology and products.
10	Biological/natural control of pests and diseases.
11	Soil solarization.
12	Frame work for GAP, case studies.
13-14	HACCP analysis, residue analysis in organic products.

Reference Book:

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

Seminar (01 credit)			
1	FSC - 591	Seminar	0+1=1
Master's Research (20 credits)			
1	Master's Research		0+20=20