

Chaudhary Charan Singh University, Meerut

**Syllabus & Course Content
of
M.Sc. (Ag.) Horticulture (New)
{2 Year (4 Semesters) Programme}**

Programme Outcomes (POs):

Horticulture, a branch of agricultural sciences, is related to the production and management of fruits, vegetables, spices, ornamentals, flowers, medicinal & aromatic plants etc. Post-graduation programme {M.Sc. (Ag.) Horticulture} reflects new methods, developments and dimensions in horticulture discipline. Horticulture curricula are unique in that they bridge not only the hard and soft sciences, but also the aesthetic, often attuned with fine art curricula (landscape design, floral art, and plant curatorship, garden history and restoration). Horticulture curricula, unless of a purely limited technical nature, include courses in basic science, aesthetics, humanities, public education, business, and environmental science. The curriculum has strong theoretical and practical focus with the students being trained in production and management of horticultural crops. This programme also develops skill in designing & developing a garden (commercial, nutritional, or ornamental). This also skills the aspirants to hi-tech production of horticultural crops for nutritional, health and environmental security. The postharvest management strategies offer an opportunity to invest in postharvest processing and value addition industries.

Programme Specific outcomes (PSOs):

PSO1.

Students have basic and advance knowledge in the field of horticultural sciences including crop production, nutrient management, intercultural operations, insect-pest and disease management, postharvest management and economics of cultivation of concerned crops.

PSO2.

Students have better understanding and high skill on breeding methods, crop production, postharvest handling & preservation, experimental tools in soil samples, plant nursery development, garden development, statistical tools & analysis, research data computation etc., required for higher learning in horticultural sciences.

PSO3.

Students become able to design and execute individual research project, write concise & persuasive research articles and communicate effectively with their scientific colleagues, farmers and the general public.

PSO4.

Students become eligible to work in commercial horticultural units, gardening & landscape architecture units, nursery raising, seed production companies, food industries, research projects, postharvest processing industries etc.

PSO5. Students able to address complex problems taking into account related fruit crops, vegetables & spices crops, flower crops, ornamentals plants, medicinal & aromatic plants, economic and environmental issues.

SEMESTER-I

1. Course Title: Production of Vegetable Crops

Credit Hours: 5(4+1)

i. Importance of the Course

Vegetables, also called 'protective food', are a major source of dietary fibres, minerals and vitamins. Some of these vegetables also contribute protein, fat and carbohydrate. Most of the leafy and root vegetables are rich in minerals, especially in micro-elements such as copper, manganese and zinc. On the basis of temperature requirement, vegetables can be classified in two groups i.e. cool and warm season vegetable. The students of vegetable science need to have a well understanding of production technology of important vegetable crops and their management.

ii. Theory

Introduction, commercial and nutritional importance, origin and distribution, area and production, soil and climate, commercial varieties/ hybrids, seed rate and seed treatment, sowing/planting, manures & fertilizer requirement, irrigation requirement, intercultural operations, special horticultural practices, weed control, use of plant growth regulators, physiological disorders, insect-pests and disease management, maturity indices, harvesting and yield of vegetable crops mentioned in following units-

Unit-I

Fruit vegetables: -Tomato, brinjal, hot pepper, sweet pepper and okra.

Unit-II

Cole crops: -Cabbage, cauliflower, knolkhol and broccoli.

Unit-III

Root crops: -Carrot, radish, turnip and beetroot.

Unit-IV

Leguminous vegetables: - Pea, French-bean, cow-pea, broad bean

Unit-V

Cucurbits: - Cucumber, muskmelon, watermelon, bottle gourd, bitter gourd, sponge gourd, ridge gourd and pumpkin

Unit-VI

Bulb and tuber crops:-Onion, garlic, potato, sweet potato and elephant-foot yam.

Unit-VII

Green leafy vegetables: - Spinach, amaranth and lettuce

iii. Practical

- 1) To study vegetable seed bed preparation
- 2) To study sowing and transplanting methods used in vegetables production
- 3) To study irrigation methods used in vegetable crops production
- 4) To study about fertilizer application methods in vegetables

- 5) To study about plant bio-regulators application in vegetables
- 6) To study about calculation of cost of cultivation of important vegetables
- 7) Visit to nearby horticultural research institute & production farms.

iv. Teaching Methods/ Activities

- 1) Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
- 2) Assignment (written and speaking)
- 3) Student presentation
- 4) Hands on training of different practices
- 5) Group discussion

v. Course Outcomes (COs) /Learning Outcomes (LOs)

After successful completion of this course, the students are expected to:

- 1) Appreciate the scope and scenario of vegetable crops in India
- 2) Acquire knowledge about the production technology vegetable crops
- 3) Acquire knowledge about plant protection practices in vegetable crops
- 4) Calculate the economics and cost of production of vegetable crops.

vi. Suggested Reading

- 1) Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
- 2) Bose TK, Som MG and Kabir J. (Eds.). 1993. *Vegetable Crops*. Naya Prokash.
- 3) Chadha KL. (Ed.). 2002. *Handbook of Horticulture*. ICAR.
- 4) Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad and Sons.
- 5) Fageria MS, Choudhary BR and Dhaka RS. 2000. *Vegetable Crops: production technology*. Vol. I & II. Kalyani publishers.
- 6) Hazra P. 2019. *Vegetable production and technology*. New India publishing agency, New Delhi.
- 7) Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. *Modern technology for vegetable production*, New India publishing agency, New Delhi, 413p
- 8) Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani publishers, New Delhi.
- 9) Saini GS. 2001. *A text book of Oleri and Flori culture*. Aman publishing house.
- 10) Singh DK. 2007. *Modern vegetable varieties and production technology*. International bookdistributing Co.
- 11) Thamburaj S and Singh N. (Eds.), 2004. *Vegetables, tuber crops and spices*. ICAR.

2. Course Title: Propagation and Nursery Management of Fruit Crops

Credit Hours: 5(4+1)

i. Importance of the Course

Plant propagation is an art and science which requires knowledge, skill, manual dexterity and experience for successful multiplication of plants. Fruit plant propagation is necessary for multiplication of fruit plants which have better genetic purity, minimizing gestation period and good in quality. This necessitates requisite skill and efficient multiplication protocols for raising plants prior to distribution or field transfer.

ii. Theory

Unit-I:

Introduction to plant propagation, sexual and asexual methods of propagation with their advantages and disadvantages, apomixes, polyembryony. Factors influencing seed germination of fruit crops, seed dormancy and its types, hormonal regulation of seed germination and seed treatment.

Unit-II:

Cutting: Principles and methods of propagation by softwood, hardwood and herbaceous cuttings. Factors affecting rooting of cuttings.

Layering: Principles and methods of layering. Factors affecting rooting in layering.

Budding and grafting: Principles and methods of budding and grafting. Stock, scion and inter stock relationship. Stionic effect. Graft-incompatibility. Use of plant growth regulators in propagation.

Unit-III:

Principles and concepts of micro-propagation. Methods of micro-propagation, organogenesis and embryogenesis.

Unit-IV

Nursery types, components, planning and layout. Nursery management practices for healthy propagule production. Propagation structures. Disease and insect management in nursery

iii. Practical

- 1) To study about growing media used in propagation
- 2) To study about layout/preparation of fruit nursery
- 3) To study about propagation through cutting
- 4) To study about propagation through grafting
- 5) To study about propagation through layering
- 6) Hands on practice of air-layering practice in litchi
- 7) Visit to commercial fruit nurseries.

iv. Teaching Methods/ Activities

- 1) Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/

Smart LED)

- 2) Assignment (written and speaking)
- 3) Student presentation
- 4) Hands on training of different practices
- 5) Group discussion

v. Course Outcomes (COs) /Learning Outcomes (LOs)

The student would be expected to acquaintance & equip to acquire skills and knowledge on principles and practices of macro and micro-propagation and the handling of propagated material in nursery.

vi. Suggested Reading

- 1) Bose TK, Mitra SK and Sadhu MK. 1991. *Propagation of Tropical and Subtropical Horticultural Crops*. Naya Prokash, Kolkatta.
- 2) Davies FT, Geneve RL and Wilson SB. 2018. *Hartmann and Kester's Plant Propagation- Principles and Practices*. Pearson, USA/ Prentice Hall of India. New Delhi.
- 3) Gill SS, Bal JS and Sandhu AS. 2016. *Raising Fruit Nursery*. Kalyani Publishers, New Delhi.
- 4) Jain S and Hoggmann H. 2007. *Protocols for Micro propagation of Woody Trees and Fruits*. Springer.
- 5) Joshi P. 2015. *Nursery Management of Fruit Crops in India*. NIPA, New Delhi.
- 6) Rajan S and Baby LM. 2007. *Propagation of Horticultural Crops*. NIPA, New Delhi.
- 7) Sharma RR. 2014. *Propagation of Horticultural Crops*. Kalyani Publishers, New Delhi.
- 8) Sharma RR and Srivastav M. 2004. *Propagation and Nursery Management*. Intl. Book Publishing Co., Lucknow.
- 9) Singh RS. 2014. *Propagation of Horticultural Plants: Arid and Semi-Arid Regions*. NIPA, New Delhi.
- 10) Tyagi S. 2019. *Hi-Tech Horticulture*. Vol. I: *Crop Improvement, Nursery and Rootstock Management*. NIPA, New Delhi.

3. Course Title: Commercial Production of Flower Crops**Credit Hours: 5(4+1)****i. Importance of the Course**

Flowers are grown in a wide range of agro-climatic regions. The students of floriculture need to have an understanding of production and postharvest management of important flower crops on commercial scale

ii. Theory**Unit-I**

Importance, present scenario and scope of growing loose and cut flowers at commercial scale in India.

Unit-II

Commercial production of flower crops with special reference to origin, soil and climate requirement, nursery management and land preparation, propagation or seed sowing and transplanting, water and nutrient management, training and pruning, special horticultural practices such as pinching and disbudding, use of growth regulators, physiological disorders, insect-pests and diseases, harvesting and post-harvest handling of flower crops given in following sub units-

Sub-unit i

Rose, chrysanthemum, gladiolus, tuberose, carnation, gerbera, dahlia, orchids, tulip, liliium.

Sub-unit ii

Jasmine, marigold, china aster, gaillardia, gazania, zinnia.

iii. Practical

- 1) Identification of species and varieties of flower crops
- 2) Propagation and nursery management of flower crops
- 3) Training techniques used in flower crops
- 4) Pruning techniques used in flower crops
- 5) Pinching, disbudding and staking techniques used in flower crops
- 6) Postharvest handling of flower crops
- 7) Visit to the horticultural research institutes & flower production fields.

iv. Teaching Methods/ Activities

- 1) Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
- 2) Assignment (written and speaking)
- 3) Student presentation
- 4) Hands on training of different practices
- 5) Group discussion

v. Course Outcomes (COs) /Learning Outcomes (LOs)

After successful completion of this course, the students would have

- 1) A thorough understanding of nursery management of flowers crops
- 2) A thorough understanding of propagation methods of flower crops.
- 3) A thorough understanding of cultivation of flowers.
- 4) A thorough understanding of postharvest management of flower crops.

vi.Suggested Reading

- 1) Arora JS. 2010. *Introductory Ornamental Horticulture*. Kalyani Publi. 6th Edition
- 2) Bhattacharjee SK. 2018. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.Reprint,
- 3) Bose T K, Maiti RG, Dhua RS and Das P. 1999. *Floriculture and Landscaping*. Naya Prokash, Kolkata, India.
- 4) Bose TK and Yadav LP. 1989. *Commercial Flowers*. Naya Prokash, Kolkata, India.
- 5) Chadha KL and Bhattacharjee S K. 1995. *Advances in Horticulture: Ornamental Plants*. Vol. XII, Parts 1 & 2. Malhotra Publ. House, New Delhi, India.
- 6) Chadha KL and Chaudhury B.1992. *Ornamental Horticulture in India*. ICAR, New Delhi, India.
- 7) Laurie A and Rees VH. 2001. *Floriculture-Fundamentals and Practices*. Agrobios Publ., Jodhpur.
- 8) Prasad S and Kumar U. 2003. *Commercial Floriculture*. Agrobios Publ., Jodhpur.
- 9) Randhawa GS and Mukhopadhyay A. 2001. *Floriculture in India*. Allied Publication
- 10) Sheela VL. 2008. *Flowers for Trade*. Horticulture Science Series, vol.10, pp. 392. New IndiaPubl. Agency, New Delhi, India.

4. Course Title: Statistical Methods and Experimental Designs

Credit Hours: 5(4+1)

i. Importance of the Course

This course is meant for students who do not have sufficient background of statistical methods. The students would be exposed to concepts of general statistical methods, and statistical inference that would help them in understanding the importance of statistical methodology. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation of results.

ii. Theory

Unit-I

Processing of data-Diagrammatic and graphical representation of data bars, histogram, frequency curves and polygon.

Unit-II

Measures of Central Tendency and Dispersion-Mean, median, mode and quartile deviation, mean deviation & standard deviation.

Unit-III:

Probability and Distribution-Probability, Addition and multiplication law of probability.

Unit-IV

Correlation- Karl Pearson's correlation coefficient, rank correlation.

Unit-V

Testing of Hypothesis-Null and alternative hypothesis. Tests of significance- chi-square test for testing goodness of fit, t test and z test for testing equality of two means, and F test for testing the equality of two variance and homogeneity of means.

Unit-VI

Experimental designs- Analysis of variance with one way and two-way classification. Design of Experiment- Basic principle of experimental design, completely randomized design (CRD), randomized block design (RBD) and Latin square design (LSD).

Practical

- 1) Calculating of A.M., median and mode.
- 2) Correlation- Rank correlation and partial correlation.
- 3) Law of addition and multiplication of probability
- 4) To draw histogram, frequency curve and polygon
- 5) Calculation and analysis of Z-test
- 6) Analysis of completely randomized design (CRD).
- 7) Analysis of completely Randomized block design (CRBD)

ii. Teaching Methods/ Activities

1. Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
2. Assignment (written and speaking)

3. Student presentation

iii. **Course Outcomes (COs) /Learning Outcomes (LOs)**

After successful completion of this course, the students are expected to be able to:

- 1) Processing and analysis of data related to research work
- 2) Formulate complete, concise, and correct statistical **proofs**
- 3) Use of suitable experimental design for research work

iv. **Suggested Reading**

- 1) Aggarwal BL. 1996. *Basic Statistics*. Wiley Eastern Limited, New Age International Ltd.
- 2) Bansal ML, Singh S, Singh TP and Kumar R. 2004. *Statistical Methods for Research Workers*. Kalyani Publishers.
- 3) Chandel SRS. 2014. *A Handbook of Agricultural Statistics*. Achal Prakashan.
- 4) Ireland C. 2010. *Experimental Statistics for Agriculture and Horticulture*. CABI
- 5) Goon AM, Gupta MK and Dasgupta B. 1968. *Fundamentals of Statistics*, vol I and II. The World Press, Calcutta.
- 6) Snedecor GW and Cochran WG. 1980. *Statistical Methods*. East West Press.

SEMESTER-II

1. Course Title: Production of Fruit Crops

Credit Hours: 5(4+1)

i. Importance of the 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 fruit crops.

ii. Theory

Unit-I

Importance, present scenario, scope and export potential of fruit production in India. Challenges and bottlenecks of fruit production in India.

Unit-II

Commercial production of fruit crops with special reference to origin, economic and nutritional importance, soil and climate requirement, propagation/nursery arising, planting time and distance, commercial varieties, irrigation and nutrient management, training and pruning, special horticultural practices, use of growth regulators, crop regulation, flowering and fruit set, physiological disorders, insect-pests and diseases, Harvest indices, harvesting, yield and post-harvest handling and storage of fruits crops mentioned in following sub units-

Sub-unit I

Apple, peach, pear, plum, strawberry, apricot, walnut and cherry.

Sub-unit II

Mango, banana, papaya, sapota, guava, jackfruit and pineapple

Sub-unit III

Grape, citrus, litchi, loquat, pomegranate, ber, phalsa and aonla.

iii. Practical

1. Identification of fruit plants.
2. To study about planting system in fruit plants.
3. To study about training and pruning practices used in fruit crops.
4. Hands on practice on propagation of mango, litchi, grapes and papaya.
5. Fruit plant's physiological disorders-malady diagnosis
6. Fruit plant's disease-malady diagnosis
7. Visit to commercial orchards located nearby to CCS University, Meerut.

iv. Teaching Methods/ Activities

1. Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
2. Assignment (written and speaking)

3. Student presentation
4. Hands on training of different practices
5. Group discussion

v. Course Outcomes (Cos) /Learning Outcomes (LOs)

After successful completion of this course, the students would have-

1. A thorough understanding of fruit nursery and propagation
2. A thorough understanding of principles and practices used in production of fruits.
3. A thorough understanding of postharvest handling of fruits.

vi. Suggested Reading

- 1) Bose TK, Mitra SK and Sanyal D. 2002. *Fruits of India – Tropical and Sub-Tropical*. 3rd Ed. Naya Udyog, Kolkata.
- 2) Dhillon WS. 2013. *Fruit Production in India*. Narendra Publ. House, New Delhi.
- 3) Midmore D. 2015. *Principles of Tropical Horticulture*. CAB International. Mitra SK and Sanyal D. 2013. *Guava*, ICAR, New Delhi.
- 4) Morton JF. 2013. *Fruits of Warm Climates*. Echo Point Book Media, USA
- 5) Rani S, Sharma A and Wali VK. 2018. *Guava (Psidium guajava L.)*. Astral, New Delhi.
- 6) Robinson JC and Sauco VG. 2010. *Bananas and Plantains*. CAB International.
- 7) Sandhu S and Gill BS. 2013. *Physiological Disorders of Fruit Crops*. NIPA, New Delhi.
- 8) Sharma KK and Singh NP. 2011. *Soil and Orchard Management*. Daya Publishing House, New Delhi.
- 9) Banday FA and Sharma MK. 2018. *Advances in Temperate Fruit Production (2nd ed.)*. Kalyani Publishers, New Delhi

2. Course Title: Breeding of Vegetable Crops**Credit Hours: 5(4+1)****i. Importance of the Course**

Vegetable breeding, an art and science of changing the traits of plants in order to produce desired traits, has been used to improve the quality of nutrition in products for human beings. Breeding high yielding open pollinated varieties and hybrids, and exploitation of location specific component of genotypic performance are the only options left to reduce this increasing gap between the production and requirements in view of decreasing land resources. No ever the less, vegetable breeding is an integral part of plant breeding but this will be re-modeled to suit to breeding of different vegetables crops. The students of vegetable science who are having breeding as major subject need to have an understanding of vegetable breeding principles.

ii. Theory**Unit-I**

Importance, history and evolutionary aspects of vegetable breeding. Centre of origin and genetic variability of vegetable crops.

Unit-II

Mechanism of self and cross pollination. Breeding procedure and techniques of self and cross pollinated vegetable crops.

Unit-III

Hybridization technique for vegetables. Type and mechanism of heterosis breeding. Hybrid seed production techniques for tomato, brinjal, pea, cauliflower, cabbage and radish.

Unit-IV

Mutation and Polyploidy breeding.

Unit-V

Breeding for biotic stress (diseases, insect pests and nematode) resistance. Breeding for abiotic stress (temperature, moisture and salt) resistance.

iii. Practical

- 1) Floral biology and pollination behaviour of different vegetables.
- 2) Techniques of selfing and crossing of different vegetables.
- 3) To study hybridization technique of tomato
- 4) To study hybridization technique of brinjal
- 5) To study hybridization technique of okra
- 6) To study hybridization technique of pea
- 7) Visit to research institutes and breeding and seed production farms.

iv. Teaching Methods/ Activities

1. Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)

2. Assignment (written and speaking)
3. Student presentation
4. Hands on training of different practices
5. Group discussion

v. **Course Outcomes (COs) /Learning Outcomes (LOs)**

After successful completion of this course, the students are expected to:

- 1) Acquire knowledge about the principles of vegetable breeding
- 2) Improve yield, quality, abiotic and biotic resistance, and other important traits of vegetable crops
- 3) Understand how the basic principles are important to start breeding of vegetable crops.

vi. **Suggested Reading**

- 1) Allard RW. 1960. *Principle of Plant Breeding*. John Willey and Sons, USA. Kalloo G. 1988. *Vegetable breeding* (Vol. I, II, III). CRC Press, FI, USA.
- 2) Prohens J and Nuez F. 2007. *Handbook of Plant Breeding-vegetables* (Vol I and II). Springer, USA.
- 3) Singh BD. 2007. *Plant Breeding- principles and methods* (8th edn.). Kalyani Publishers, New Delhi.
- 4) Singh Ram J. 2007. *Genetic resources, chromosome engineering, and crop improvement-vegetable crops* (Vol. 3). CRC Press, FI, USA.

3. Course Title: Ornamental Gardening and Landscaping

Credit Hours: 5(4+1)

i. Importance of the Course

Ornamental gardening and landscaping is an important course which gives a thorough understanding of different types of gardens and their components. Ornamental gardening and landscaping, now a day, playing vital role in beautification of living areas, surroundings as well as whole environment. Plantation of ornamental plants for gardening and landscaping escapes pollutants and mitigates environmental pollution. The students need to imbibe the principles of landscaping and should develop skills for bio-aesthetic planning under different sites.

ii. Theory

Unit-I

History, importance and scope of ornamental gardening and landscaping in India. Styles and types of gardens i.e. formal and informal style of gardens. English, Mughal, Japanese, Persian, Spanish, Italian, French and Buddhist gardens and their features

Unit-II

Principles of landscape gardening: Initial approach, Axis, Focalization, Balance, Mass effect, Unity, Space, Divisional lines, Proportion and scale, Time and light, Rhythm, Mobility, Texture, Color and tone and Focal point.

Unit-III

Living components of garden: arboretum, shrubbery, fernery, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, colour wheels, clock garden, bamboo groves, bonsai. **Non -living components** like- path, garden gate, fencing, paving and garden features like fountains, garden seating, swings, lanterns, basins, bird baths, sculptures, waterfalls, bridge, steps, ramps, Lawn-genera and species, establishment and maintenance.

Unit-IV

Specialized gardens such as vertical garden, roof garden, terrace garden, water garden, sunken garden, rock garden, shade garden, temple garden, sacred gardens, and Zen garden

Unit-V

Planning and landscaping for different locations such as residential area, farm houses, institutions, industries, hospitals, roadsides, children parks, public parks, airports, railway station, railway line, road side, river banks and dam sites. Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening and therapeutic gardening.

iii. Practical

- 1) Identification and description of various types of ornamental plants
- 2) Identification and description of various types of flowering plants
- 3) Preparation of garden models for home gardens
- 4) Preparation of garden models for educational institute.
- 5) Study about the maintenance and establishment of lawn.
- 6) Hands on training on different gardening practices
- 7) Visit to research institutes/ornamental gardens.

iv. Teaching Methods/ Activities

- 1) Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
- 2) Assignment (written and speaking)
- 3) Student presentation
- 4) Hands on training of different practices
- 5) Group discussion

v. Course Outcomes (Cos) /Learning Outcomes (LOs)

After successful completion of this course, the students are expected to be-

- 1) The students will be apprised of different types of gardens and have a thorough understanding of principles of landscape gardening
- 2) Develop skills for landscaping under different situations and layout of garden components.

vi. Suggested Reading

- 1) Bose TK, Chowdhury B and Sharma SP. 2011. *Tropical Garden Plants in Colour*. Hort. and Allied Publ.
- 2) Bose TK, Maiti RG, Dhua RS and Das P. 1999. *Floriculture and Landscaping*. Naya Prokash, Kolkata, India.
- 3) Grewal HS and Singh P. 2014. *Landscape Designing and Ornamental Plants*. Kalyani Publishers, New Delhi.
- 4) Lauria A and Victor HR. 2001. *Floriculture-Fundamentals and Practices*. Agrobios Publ., Jodhpur.
- 5) Misra RL and Misra S. 2012. *Landscape Gardening*. Westville Publ. House, New Delhi, India.
- 6) Nambisan KMP. 1992. *Design Elements of Landscape Gardening*. Oxford & IBH Publ. Co., New Delhi, India.
- 7) Randhawa GS and Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
- 8) Sabina GT and Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency, New Delhi, India.
- 9) Singh A and Dhaduk BK. 2015. *A Colour Handbook: Landscape Gardening*. New India Publ. Agency, New Delhi, India

4. Course Title: Production of Plantation and Spices Crops

Credit Hours: 5(4+1)

i. Importance of the Course

Plantation and spice crops play an important role in the national economy of India. These crops also provide livelihood security to a large section of farmers. This course will impart knowledge to the learner on advanced scientific production technology of various plantation and spices crops in Indian perspectives. Hi-tech production technologies will be discussed in this course.

ii. Theory

Unit-I

Importance and scope of plantation and spices crops in present scenario of national economy. Scope to enter in plantation and spices industries. Production challenges of plantation and spices crops. Export scenario and market opportunities in plantation and spice crops.

Unit-II

Production of plantation and spices crops with special reference to origin, uses and importance, major growing states, soil and climate requirement, nursery management, mass-multiplication technique, planting time and distance, transplanting, commercial varieties, irrigation and nutrient management, training and pruning, special horticultural practices, use of growth regulators, physiological disorders, insect-pests and diseases, Harvesting and yield, post-harvest handling, and storage of plantation & spices crops mentioned in following sub units-

Sub-unit I

Coconut, Arecanut, Cashew, Coffee, Tea, and Cocoa.

Sub-unit II

Black pepper, Cardamom, Ginger, Turmeric, Hot pepper, Coriander, Cumin and Fenugreek.

iii. Practical

- 1) Botanical description and identification of plantation and spices crops
- 2) Nursery techniques in plantation and spices crops
- 3) Nutrient deficiency symptoms in plantation and spices crops
- 4) Pruning and training methods used in plantation and spices crops
- 5) Maturity standards of plantation and spices crops
- 6) Postharvest techniques used in spices
- 7) Visits to plantation/spices farm near by CCS, University, campus, Meerut

iv. Teaching Methods/ Activities

1. Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
2. Assignment (written and speaking)

3. Student presentation
4. Hands on training of different practices
5. Group discussion

v. Course Outcomes (Cos) /Learning Outcomes (LOs)

After successful completion of this course, the students are expected to:

- 1) Develop the technical skill in commercial cultivation of plantation and spices crops
- 2) Be able to start plantation and spices crop-based enterprises

vi. Suggested Reading

- 1) Agarwal S, Sastry EVD and Sharma RK. 2001. *Seed Spices: Production, Quality, Export*. Pointer Publ. Agency.
- 2) Arya PS. 2003. *Spice Crops of India*. Kalyani.
- 3) Bose TK, Mitra SK, Farooqi SK and Sadhu MK. Eds. 1999. *Tropical Horticulture*. Vol.I. Naya Prokash.
- 4) Chadha KL and Rethinam P. Eds. 1993. *Advances in Horticulture*. Vols. IX-X. *Plantation Crops and Spices*. Malhotra Publ. House.
- 5) Choudappa P, Niral V, Jerard BA and Samsudeen K. 2017. *Coconut*. Daya Publishing House, New Delhi.
- 6) Joshi P. 2018. *Text Book on fruit and plantation crops*. Narendra Publishing House, New Delhi
- 7) Kumar NA, Khader P, Rangaswami and Irulappan I. 2000. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants*. Oxford and IBH.
- 8) Nybe EV, Miniraj N and Peter KV. 2007. *Spices*. New India Publ. Agency.
- 9) Peter KV. 2001. *Hand Book of Herbs and Spices*. Vols. I-III. Woodhead Publ. Co. UK and CRC USA.
- 10) Peter KV. 2002. *Plantation Crops*. National Book Trust.
- 11) Pruthi JS. Ed. 1998. *Spices and Condiments*. National Book Trust.

SEMESTER-III

1. Course Title: Production of Medicinal and Aromatic Crops

Credit Hours: 5(4+1)

4. Importance of the Course

Medicinal and aromatic crops play an important role in the national economy as well as herbal care systems in India. These crops also provide health security to all. This course will impart theoretical as well as hands-on experience to the learner on scientific production technology of various medicinal and aromatic crops in Indian perspectives. This course will provide comprehensive knowledge in this regard.

5. Theory

Unit-I

Importance and scope of medicinal and aromatic plants. Role of medicinal and aromatic plants in national economy. Classification of medicinal and aromatic crops. Medicinal Plant Board and NGO's in research and development of medicinal and aromatic crops

Unit-II

Production of medicinal and aromatic crops with special reference to origin, uses and importance, major growing states, soil and climate requirement, nursery management, mass-multiplication technique, planting time and distance, transplanting, commercial varieties, irrigation & nutrient management, special horticultural practices, use of growth regulators, insect-pests and diseases, Harvesting, yield and post-harvest handling and storage of medicinal & aromatic crops mentioned in following sub units-

Sub-unit I

Senna, Periwinkle, Aswagandha, Sarpagandha, *Dioscorea*, *Aloe Vera*, Isabgol, Safedmusli and Stevia.

Sub-unit II

Palmarosa, Lemongrass, Citronella, Mentha, Vetiver, Ocimum, Patchouli and Geranium.

6. Practical

- 1) Botanical description and identification of medicinal plants
- 2) Botanical description and identification of aromatic plants
- 3) Nursery preparation for medicinal and aromatic plants
- 4) Fertilizer management in medicinal and aromatic plants
- 5) Maturity and harvesting standards of medicinal and aromatic plants
- 6) Essential oil extraction methods and procedures
- 7) Visit to botanical garden and herbariums.

7. Teaching Methods/ Activities

- 1) Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
- 2) Assignment (written and speaking)
- 3) Student presentation
- 4) Hands on training of different practices
- 5) Group discussion

8. Course Outcomes (COs) /Learning Outcomes (LOs)

After successful completion of this course, the students are expected to:

- 1) Develop the technical skill in commercial cultivation of medicinal and aromatic crops
- 2) Be able to start medicinal and aromatic crop-based enterprises

9. Suggested Reading

- 1) Atal CK and Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.
- 2) Barche S. 2016. *Production technology of spices, aromatic, medicinal and plantation crops*. New India Publishing Agency, New Delhi.
- 3) Das K. 2013. *Essential oils and their applications*. New India Publishing Agency, New Delhi
- 4) Farooqi AA and Sriram AH. 2000. *Cultivation Practices for Medicinal and Aromatic Crops*. Orient Longman Publ.
- 5) Farooqi AA, Khan MM and Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd.
- 6) Gupta RK. 2010. *Medicinal and Aromatic plants*. CBS publications.
- 7) Panda H. 2002. *Medicinal Plants Cultivation and their Uses*. Asia Pacific Business Press. Panda H. 2005. *Aromatic Plants Cultivation, Processing and Uses*. Asia Pacific Business Press.
- 8) Ponnuswami *et al.* 2018. *Medicinal Herbs and Herbal Cure*. Narendra Publishing House, New Delhi.
- 9) Prajapati SS, Paero H, Sharma AK and Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios.
- 10) Skaria PB, Samuel M, Gracy Mathew, Ancy Joseph, Ragina Joseph. 2007. *Aromatic Plants*. New India Publ. Agency.

2. Course Title: Postharvest Management of Horticultural Produce

Credit Hours: 5(4+1)

i. Importance of the Course

Horticultural products are of perishable in nature that suffer great losses both in quantity and quality after harvest. These produce require integrated approach to arrest their spoilage and overcome the present day challenges that assimilates millions of tons annually. Lack of postharvest awareness and absence of sufficient and functioning equipment in the postharvest chain results in serious postharvest losses in developing countries. Clear and comprehensive understanding of postharvest deteriorative factors is necessary to overcome these challenges. Pre and postharvest management such as good cultural practices, use of improved varieties, good handling practices; pre and postharvest temperature and relative humidity management, storage atmosphere management, use of permitted chemicals, design of appropriate packaging materials and storage structures are some of the control measures to minimize/ reduce postharvest losses. Hence this customized course will provide comprehensive knowledge in this regard.

ii. Theory

Unit-I:

Importance and scope of postharvest technology of horticultural produce. Pre-harvest and postharvest losses of horticultural produce.

Unit-II:

Pre and postharvest factors related to post harvest deterioration of horticultural crops. Physiological and biological changes during and after maturity in horticultural crops.

Unit-III:

Maturity indices for harvesting. Time and methods of harvesting. Harvesting tools. Climacteric and non-climacteric fruits. Hastening and delaying ripening process in fruits.

Unit-IV:

Pre and postharvest treatment of horticultural crops. Pre-cooling, washing, curing, sorting, grading, VHT, irradiation treatment, skin coating, de-greening, control of sprouting, rooting and discoloration, pre-packaging and packaging techniques, storage & its types, modes of transportation and marketing.

Unit-V:

Role of sugar, growth regulators and chemicals on vase-life of flowers. Special features such as bent neck, geotropic bending and foliage discoloration in flowers and ornamentals. Pulsing and holding solution.

iii. Practical

- 1) Study of maturity indices for harvest of fruits, vegetables, spices and plantation crops;
- 2) Control of sprouting of potato and onion by using growth regulators
- 3) Study of pre-harvest factors related to post harvest deterioration of

horticultural crops

- 4) Study of post-harvest factors related to post harvest deterioration of horticultural crops
- 5) Study of effect of pre-cooling on shelf-life and quality of fresh fruits, vegetables and flowers;
- 6) Packaging methods used for horticultural produce
- 7) Visit to local markets and super markets dealing with marketing of Perishables.

iv. Teaching Methods/ Activities

1. Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
2. Assignment (written and speaking)
3. Student presentation
4. Hands on training of different practices
5. Group discussion

v. Course Outcomes (COs) /Learning Outcomes (LOs)

After successful completion of this course, the students are expected to:

- 1) Regulation of ripening by use of chemicals and growth regulators
- 2) Pre and Postharvest treatments for extending storage life/ vase life

vi. Suggested Reading

- 1) Bhattacharjee SK and Dee LC. 2005. *Postharvest technology of flowers and ornamental plants*. Pointer publishers, Jaipur.
- 2) Chattopadhyay SK. 2007. *Handling, transportation and storage of fruit and vegetables*. Gene- Tech books, New Delhi.
- 3) Kader AA. 1992. *Postharvest technology of horticultural crops*. 2nd ed university of California.
- 4) Paliyath G, Murr DP, Handa AK and Lurie S. 2008. *Postharvest Biology and Technology of Fruits, Vegetables and Flowers*, Wiley-Blackwell,
- 5) Stawley J Kays. 1998. *Postharvest physiology of perishable plant products*. CBS publishers.
- 6) Sudheer KP, Indira V. 2007. *Postharvest Technology of Horticultural Crops*, Peter K.V. (Ed.), New India Publishing Agency,
- 7) Thompson AK. (Ed.) 2014. *Fruit and Vegetables: Harvesting, Handling and Storage* (Vol. 1 & 2) Blackwell Publishing Ltd, Oxford, UK.
- 8) Verma LR and Joshi VK. 2000. *Postharvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management*. Indus Publishing Company, New Delhi, India.
- 9) Wills RBH and Golding J. 2016. *Postharvest: an introduction to the physiology and handling of fruit and vegetables*, CABI Publishing,
10. Wills RBH and Golding J. 2017. *Advances in Postharvest Fruit and Vegetable Technology*, CRC Press,

SEMESTER-IV

1. Course Title: Principles and Methods of Fruit and Vegetable Preservation

Credit Hours: 5(4+1)

i. Importance of the Course

The fruits and vegetables have comparatively higher nutritional and economic values than cereals and are more perishable. Losses in the fruits and vegetables are high and chances to reduce the waste and enhancing the employability through post-harvest processing are more. The processing includes pre-processing of fruits and vegetables before these are fit to final conversation into processed foods. The food preservation and processing industry has now become a necessity than being a luxury. It has an important role in conservation and better utilization of fruits and vegetables. In order to avoid the glut and utilize the surplus during the season, it is necessary to employ modern methods to extend storage life for better distribution and also processing techniques to preserve them for utilization in the off season on both large scale and small scale. Hence this customized course will provide comprehensive knowledge and practices for processing and preservation of fruits & vegetables for commercial and off-season uses.

ii. Theory

Unit-I: Introduction, Historical development in food processing. Basic principles and methods of fruits and vegetables preservation. Enzymatic and textural changes during processing. Colours, flavours and preservatives used in preservation.

Unit-II:

Canning-principles & method, Preservation by drying and dehydration. Preservation by freezing. Cryogenic preservation. Preservation by radiation.

Unit-III:

Preservation by sugar- jam, jelly, marmalade. Fruit preserves. Fruit beverages, Juice, Squash & Cordial. Pickles, Tomato products.

Unit-IV:

Fermentation: alcoholic, acetic and lactic fermentation. Preservation by irradiation. Role of sugar, salt, oil and spices in fruit & vegetable preservation.

Unit-V:

Types of containers used for persevered produce. FPO, FSSAI and food standards.

iii. Practical

- 1) Study of canning process of pea.
- 2) Study of different types of spoilages in fresh as well as processed horticultural products.
- 3) Preparation of jam, jelly, fruit squash, mixed pickles and tomato products.
- 4) Study of equipment's used for home and commercial preservation of fruits and vegetables.

- 5) To study about types of container used for preserved produce
- 6) Study of preservatives used in food preservation
- 7) Visit to food processing & preservation units

iv. Teaching Methods/ Activities

1. Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
2. Assignment (written and speaking)
3. Student presentation
4. Hands on training of different practices
5. Group discussion

v. Course Outcomes (Cos) /Learning Outcomes (LOs)

After successful completion of this course, the students are expected to be able to:

- 1) Understand Principles and different methods of preservation of horticultural produce.
- 2) Principal spoilage organisms, food poisoning and their control measures
- 3) Canning and other methods of fruits and vegetables preservation.
- 4) Processing equipment and layout of processing/preservation industry

vi. Suggested Reading

- 1) Barret DM, Somogyi LP and Ramaswamy H. Eds. 2005. *Processing Fruits: Science and Technology* (2nd Edition), CRC Press.
- 2) FAO. 2007. *Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas- Technical Manual*. FAO Agricultural Services Bulletin 149.
- 3) Fellows PJ. 2009. *Food Processing Technology: Principles and Practice* (3rd Edition), Woodhead Publishing.
- 4) Lal G, Siddappa GS and Tandon GL. 1998. *Preservation of Fruits and Vegetables*. ICAR,
- 5) Ramaswamy H and Marcotte M. 2006. *Food Processing: Principles and Applications*. Taylor & Francis.
- 6) Salunkhe DK and Kadam SS. 1995. *Handbook of Fruit Science and Technology- Production, Composition and Processing*. Marcel Dekker.
- 7) Srivastava RP and Kumar S. 2014. *Fruit and Vegetable Preservation: Principles and Practices* (3rd Edition), CBS Publishing.
- 8) Verma LR and Joshi VK. 2000. *Postharvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management*. Indus Publishing Company, New Delhi, India. ISBN 8173871086.

2. Course Title: Advances in Horticulture

Credit Hours: 5 (4+1)

i. Importance of the Course

Horticulture is related to the production and management of fruits, vegetables, spices, ornamentals, flowers, medicinal & aromatic plants etc. Advances in horticulture reflects new methods, practices and dimensions in the horticulture discipline. Advances in Horticulture will give an in depth knowledge on nursery management, plant propagation, planting methods, nutrient management, new system of irrigation, plasticulture and soilless culture. Advance methods of nursery management and nutrient management,

ii. Theory

Unit I

- Introduction and contribution of horticulture in National Economy.
- Nutritional and medicinal importance of horticultural produce.
- Soil and Climate requirement of Horticultural Crops

Unit II

- Raising and Management of Nursery
- Plant Propagation and methods of propagation used for horticultural crops.
- Planting methods in fruit crops

Unit III

- Assessment of needs of nutrients and their supply to fruit plants.
- Concept of organic farming in Horticulture.
- Advance irrigation methods used in horticulture.

Unit IV

- Uses of plant growth regulators in horticulture
- Soilless culture (Hydroponics and Areoponics)
- Plasticulture: role & applications in horticulture
- Protected structures in horticulture

iii. Practical

- 1) Preparation and layout of modern nursery
- 2) Study of different methods of propagation
- 3) Methods and dose preparation of fertilizers.
- 4) Preparation of stock and working solution of plant growth regulators
- 5) Study of plantation methods of horticultural crops
- 6) Visit to horticultural research station located in Meerut.

iv. Teaching Methods/ Activities

- 1) Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
- 2) Assignment (written and speaking)
- 3) Student presentation

- 4) Group discussion

v.Course Outcomes (Cos) /Learning Outcomes (LOs)

After successful completion of this course, the students would have

- 1) Advance knowledge of new techniques and methods used in agriculture
- 2) Better understanding of application of advance methods in horticulture crop production and management.

vi. Suggested Reading.

- 1) Chadha K. L., Pareek, O. P. and Rethinam P. 2002. *Advances in Horticulture*. Malhotra Publishing House (M P H), New Delhi
- 2) Thelma B. 2017. *Advances in Horticulture*. Callisto Reference
- 3) Chadha KL. 1995. *Advances in Horticulture*. (Volume 1 to 13). Malhotra Publishing House, New Delhi.
- 4) Singh, J., Nigam, R., Hasan, W., Kumar, A. and Singh, H. 2018. *Advances in Horticulture Crops*. Weser Books, Zittau, Germany.

3. Course Title: Hi-Tech Horticulture & Protected Cultivation

Credit Hours: 5 (4+1)

i. Importance of the Course

High-tech horticulture mainly refers to horticultural operations involving the latest technologies. Hi-tech horticulture mainly relates to commercial farming system aimed at catering to the needs of both, domestic as well as export markets. It uses farming technology to increase yields, ensures high quality (usually pesticide-free) and realizes increased market value. Growing horticultural crops- fruits, vegetables and cut flowers off season or round the year is a common example of protected cultivation. Main advantages use of modern technology and protected cultivation are-Increase in yield up to 5 to 8 times, high productivity per unit area, significant saving in key inputs like water, fertilizers and pesticides; better growth and uniformity in quality; feasible even in undulating terrains, saline, water logged, sandy & hilly lands. Urban and peri-urban areas potential areas for Hi-tech horticulture and protected cultivation to meet requirements of fresh produce like vegetables, fruits and flowers round the year.

ii. Theory

Unit-I

- Introduction, importance and scope of hi-tech horticulture in India.
- Hi-tech nursery management practices & mechanization.
- Modern propagation techniques for production of quality planting material.
- Modern field preparation and planting methods.

Unit-II

- High density planting: concepts and application.
- Advanced canopy management practices.
- Micro-irrigation systems and its components;
- EC/pH based irrigation/fertigation scheduling.

Unit-III

- Growing structures, their types and cladding/covering material.
- Growing media preparation and substrate management.
- Environmental control and artificial lights in green/poly houses.
- Hi-tech harvesting techniques and handling of produce.

Unit-IV

- Protected cultivation- importance, scope, advantages and constraints in India.
- Greenhouse cultivation of important vegetables (tomato, capsicum, cucumber, melons) and fruits (strawberry),.
- Protected cultivation of important cut flowers-rose, carnation, gerbera, anthurium and Asiatic lilies.
- Integrated insect-pest and disease management.

iii. Practical

1. Acquaintance with types of protected structures and covering material.
2. Intercultural operations in protected conditions.
3. Tools and equipment-identification and application;
4. Micro propagation, Nursery raising in protrays and micro-irrigation.
5. Canopy management practices and high density planting
6. Visit to hi-tech orchards/protected growing units/nurseries.

iv. Teaching Methods/ Activities

- Classroom lectures by using ICT tools (Black board/ Whiteboard/ Projector/ Smart LED)
- Assignment (written and speaking)
- Student presentation
- Hands on training of different practices
- Group discussion

v. Course Outcomes (Cos) /Learning Outcomes (LOs)

After successful completion of this course, the students are expected to be-

- The students will be apprised of different types of protected/growing structures and have a thorough understanding of principles of hi-tech horticulture.
- Develop skills for hi-tech horticulture applications under different situations.
- The students will be able to appreciate the different methods of protected cultivation practices available for vegetable crops and flowers

vi. Suggested Reading

1. Singh DK. 2004. *'Hi- tech Horticulture*. Publisher: Agrotech Publications, Udaipur
2. Prasad S., Singh Dharm and Bharadwaj R.L. 2011. *'Hi-tech Horticulture'* Publisher: Agrobios (India)
3. Singh Balraj. 2006. *Protected Cultivation of Vegetable Crops*. by Balraj Singh; Publisher: Kalyani Publishers;
4. Singh DK. and Peter KV. (Ed.). 2014. *Protected Cultivation of Horticultural Crops*. Publisher: New India Publishing Agency.
5. Singh Brahma and Singh Balraj. 2014. *Advances in Protected Cultivation'* by Publisher: New India Publishing Agency;
6. Jha MK, Paikra SS. and Sahu M. R. Sahu. 2019. *'Protected Cultivation of Horticulture Crops*. Publisher: Educreation Publishing;
