DEPARTMENT OF HIGHER EDUCATION

RAJA MAHENDRA PRATAP SINGH UNIVERSITY, ALIGARH

AS PER THE ICAR-Sixth Deans' Committee

Course Curriculum of M.Sc. (Ag.) HORTICULTURE

Course Curriculum of M.Sc. (Ag.) Horticulture
(Based on Restructured and Revised Syllabi of PG Programme by ICAR)

1st Year (1st Semester)			Evaluation Marks			
Code No.	**Course Title**	**Credit Hours**	**Mid Term (Internal)**	**Practical (External)/ Assignment (Internal 2)**	**End term/Final (External)**	**Total**
HORT-501	Production Technology of Cool Season Vegetables Crops	3(2+1)	20	30	50	100
HORT- 502	Ornamental Gardening and Landscaping	3(2+1)	20	30	50	100
HORT- 503	Subtropical and Temperate Fruit Production	3(2+1)	20	30	50	100
	Elective	3(3+0)	40	10	50	100
AST 501	Experimental Design	3(2+1)	20	30	50	100
PGS 501	Basic Concepts in Laboratory Technique	1(0+1)	40	10	-	50
PGS 502	Intellectual Property and Its Management in Agriculture	1(1+0)	-	-	50	50
	Total Credit	**17**				**600**

1st Year (2nd Semester)			Evaluation Marks			
HORT-504	Production of Warm Season Vegetable Crops	3(2+1)	20	30	50	100
HORT-505	Tropical Fruit Production	3(2+1)	20	30	50	100
HORT-506	Commercial Production Technology of cut and loose flowers	2(1+1)	20	30	50	100
	Elective	3(2+1)	20	30	50	100
AST 502	Date Analysis Using Statistical Packages	3(2+1)	20	30	50	100
PGS 503	Agriculture Research, Research Ethic and Rural Development Programmes	1(1+0)	-	-	50	50

PGS 504	Library and Information Services	1(0+1)	40	10	-	50
	Total Credit	**16**				**600**
2nd Year (3rd Semester)			**Evaluation Marks**			
HORT-507	Propagation and Nursery Management of Horticulture crops	2(1+1)	20	30	50	100
HORT-508	Commercial Production Technology of Plantation Medicinal, Aromatic and Spice crops	3(2+1)	20	30	50	100
HPRT-509	Breeding of Horticulture Crops	2(1+1)	20	30	50	100
	Elective	2(1+1)	40	10	50	100
PGS 505	Technical Writing and Communications Skills	1(0+1)	-	100	-	100
	Total Credit	**11**				**500**
2nd Year (4th Semester)			**Evaluation Marks**			
HORT-510	Master Seminar	1(0+1)	-	100	-	100
HORT- 511A	Master Research (Thesis)	30	Satisfactory/ Unsatisfactory			
OR						
HORT- 511B	IDEA(Internship for Development of Entrepreneurship In Agriculture)	30	Satisfactory/ Unsatisfactory			
	TOTAL	**1+30**				**100**
	Grand total credit hours	**45+30=75**				**1800**

M.Sc. (Ag.) Horticulture

The following nomenclature and Credit Hrs. are following while structuring Syllabus:

A. Course Work	Course Code	Allotted Credit Hours
1. Major Course	HORT- 501 To HORT- 509	25
2. Minor Course	Elective	08
3. Supporting Course	AST-501 & AST-502	06
4. Common Course	PGS-501 To PGS-505	05
5. Seminar	HORT- 510	01
B. 1.Thesis Research/ IDEA	Master Research or IDEA	30
Total		**75**

List of Minor Papers for Other Departments

Sr. No.	**Course Code**	**Course Name**	**Allotted Credit Hours**
1	HORT-501	Production Technology of Cool Season Vegetables Crops	3(2+1)
2	HORT-504	Production of Warm Season Vegetable Crops	3(2+1)
3	HORT-507	Propagation and Nursery Management of Horticulture crops	2(1+1)

Note: - 1. The student has to opt. Minor Courses of Minimum 8 credit hours offer by other department

2. The first course of every semester from the respective department is treated as a Minor for other department.

Detailed Syllabus
M.Sc. Horticulture
1st Semester
(HORT- 501) Production Technology of Cool Season Vegetables Crops 3(2+1)

Theory

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hydroponics' and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of following crops.

Unit I

Bulb and tuber crops—Onion, garlic and potato.

Unit II

Cole crops—Cabbage, cauliflower, kohlrabi, broccoli, Brussels sprouts and kale.

Unit III

Root crops—Carrot, radish, turnip and beetroot.

Unit IV

Peas and beans—Garden peas and broad bean.

Unit V

Leafy vegetables—Beet leaf, fenugreek, coriander and lettuce.

Practical:

- Scientific raising of nursery and seed treatment;
- Sowing and transplanting;
- Description of commercial varieties and hybrids;
- Demonstration on methods of irrigation, fertilizers and micronutrients application;
- Mulching practices, weed management;
- Use of plant growth substances in cool season vegetable crops;
- Study of nutritional and physiological disorders;
- Studies on hydroponics, aeroponics and other soilless culture;
- Identification of important pest and diseases and their control;
- Preparation of cropping scheme for commercial farms;
- Visit to commercial farm, greenhouse/ polyhouses;
- Visit to vegetable market;
- Analysis of benefit to cost ratio.

Suggested Reading

- Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. *Vegetable crops*. Vols. I-III. Naya udyog.
- Bose TK, Som MG and Kabir J. (Eds.). 1993. *Vegetable crops*. Naya prokash.
- Chadha KL and Kalloo G. (Eds.). 1993-94. *Advances in horticulture* Vols. V-X. Malhotra publ. house.
- Chadha KL. (Ed.). 2002. *Hand book of horticulture*. ICAR.
- Chauhan DVS. (Ed.). 1986. *Vegetable production in India*. Ram 5rasad and sons.

- Fageria MS, Choudhary BR and Dhaka RS. 2000. *Vegetable crops: production technology*. Vol. II. Kalyani publishers.
- Gopalakrishanan TR. 2007. *Vegetable crops*. New India publ. agency.
- Hazra P and Banerjee MK and Chattopadhyay A. 2012. *Varieties of vegetable crops in India*, (Second edition), Kalyani publishers, Ludhiana, 199 p.
- Hazra P. 2016. *Vegetable Science*. 2nd edn, Kalyani publishers, Ludhiana.
- Hazra P. 2019. *Vegetable production and technology*. New India publishing agency, New Delhi.
- Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. *Modern technology for vegetable production*, New India publishing agency, New Delhi, 413p
- Rana MK. 2008. *Olericulture in India*. Kalyani publishers, New Delhi.
- Rana MK. 2008. *Scientific cultivation of vegetables*. Kalyani publishers, New Delhi.
- Rana MK. 2014. *Technology for vegetable production*. Kalyani publishers, New Delhi.
- Rubatzky VE and Yamaguchi M. (Eds.). 1997. *World vegetables: principles, production and nutritive values*. Chapman and Hall.
- Saini GS. 2001. *A text book of oleri and flori culture*. Aman publishing house.
- Salunkhe DK and Kadam SS. (Ed.). 1998. Hand book of vegetable science and technology:production, composition, storage and processing. Marcel dekker.
- Shanmugavelu KG. 1989. *Production technology of vegetable crops*. Oxford and IBH.
- Singh DK. 2007. *Modern vegetable varieties and production technology*. International book distributing Co.
- Singh SP. (Ed.). 1989. *Production technology of vegetable crops*. Agril. Comm. Res. Centre.
- Thamburaj S and Singh N. (Eds.), 2004. *Vegetables, tuber crops and spices*. ICAR. Thompson HC and Kelly WC. (Eds.). 1978. *Vegetable crops*. Tata McGraw-Hill.

(Hort-502) Ornamental Gardening and Landscaping 3(2+1)

Theory:

Unit I:

Styles and types of gardens: Historical background of gardening, Importance and scope of ornamental gardening, styles and types of gardens, formal and informal style gardens. English, Mughal, Japanese, Persian, Spanish, Italian, French, Hindu and Buddhist gardens.

Unit II:

Garden components: Garden components (living and non-living): arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, 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 III:

Specialized gardens: Specialized gardens such as vertical garden, roof garden, terrace garden, water garden, sunken garden, rock garden, shade garden, temple garden, sacred gardens (with emphasis on native plants), Zen garden.

Unit IV:

Principles and elements of landscaping: Basic drawing skills, use of drawing instruments garden symbols, steps in preparation of garden design, programmes phase, design, phase, etc.

Elements and principles of landscape design. Organization of spaces, visual aspects of plan arrangement- view, vista and axis. Principles of circulation, site analysis and landscape, water requirement, use of recycled water.

Unit V:

Landscaping for different situations: Urban landscaping, Landscaping for specific situations such as residential, farm houses, institutions, corporate sector, industries, hospitals, roadsides, traffic islands, Children parks, public parks, xeriscaping, airports, railway station and tracks, river banks and dam sites and IT/ SEZ parks. Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening.

Practical

- Graphic language and symbols in landscaping, study of drawing instruments, viz.,'T' square, setsquare, drawing board, etc.
- Identification of various types of ornamental plants for different gardens and occasions.
- Preparation of land, planning, layout and planting, deviations from land scape principles
- Case study
- Site analysis, interpretation of map of different sites, use of GIS for selection.
- Enlargement from blue print. Landscape design layout and drafting on paper as per the scale
- Preparation of garden models for home gardens, farm-houses, industrial gardens, institutional gardens, corporate, avenue planting, practices in planning and planting of special types of gardens.
- Burlapping, lawn making, planting of edges, hedges, topiary, herbaceous and shrubbery borders.
- Project preparation on landscaping for different situations, creation of formal and informal gardens.
- Visit to parks and botanical gardens.

Suggested Reading

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

(Hort 503) Subtropical and Temperate Fruit Production 3(2+1)

Theory

Unit I:

Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements. 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. 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 in Citrus, Grapes and Litchi crop.

Unit II:

Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements. 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. 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 in Pomegranate, Apple and Pear.

Unit III:

Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements. 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. 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 in Peach, Plum and Apricot.

Unit IV:

Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements. 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. 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 in Cherries, Berries and Persimmon. .

Unit V:

Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements. 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. 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 in Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.

Practicals

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

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

(AST 501) Experimental Designs 3(2+1)

Theory

Unit I

Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control.

Unit II
Uniformity trials, size and shape of plots and blocks, Analysis of variance, completely randomized design, randomized block design and Latin square design.

Unit III
Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.

Unit IV
Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications,

Unit V
Lattice design alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

Practical
- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, Analysis of data obtained from CRD, RBD, LSD, Analysis of factorial experiments,
- Analysis with missing data,
- Split plot and strip plot designs.

Suggested Reading

- Cochran WG and Cox GM. 1957. *Experimental Designs*. 2nd Ed. John Wiley.
- Dean AM and Voss D. 1999. *Design and Analysis of Experiments*. Springer.
- Montgomery DC. 2012. *Design and Analysis of Experiments*, 8th Ed. John Wiley.
- Federer WT. 1985. *Experimental Designs*. MacMillan.
- Fisher RA. 1953. *Design and Analysis of Experiments*. Oliver & Boyd.
- Nigam AK and Gupta VK. 1979. *Handbook on Analysis of Agricultural Experiments*. IASRI Publ.
- Pearce SC. 1983. *The Agricultural Field Experiment: A Statistical Examination of Theory and Practice*. John Wiley.
- www.drs.icar.gov.in.

(PGS 501) BASIC CONCEPTS IN LABORATORY TECHNIQUES 1(0+1)

Practical
- Safety measures while in Lab.
- Handling of chemical substances.
- Use of burettes, pipettes, measuring cylinders, flasks, separators funnel, condensers. Micropipettes and vaccupets.
- Washing, drying and sterilization of glassware.
- Drying of solvents/ chemicals.
- Weighing and preparation of solutions of different strengths and their dilution;
- Handling techniques of solutions;
- Preparation of different agro-chemical doses in field and pot applications;
- Preparation of solutions of acids;
- Neutralization 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, sand bath, water bath, oil bath
- 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

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

(PGS 502) Intellectual Property and Its Management in Agriculture 1(1+0)

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' right sand 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

• Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
• Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
• Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
• Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V.Technology Generation and IPR Issues. Academic Foundation.
• Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
• 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.

1st Year (2nd Semester)

(Hort-504) Production of Warm Season Vegetable Crops 3(2+1)

Theory:
Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery including grafting technique, sowing/ planting time and methods, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices namely hydroponics, aeroponics, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marking), pest and disease management and economics of crops.

Unit I
Fruit vegetables—Tomato, brinjal, hot pepper, sweet pepper and okra.
Unit II
Beans—French bean, Indian bean (Sem), cluster bean and cowpea.
Unit III
Cucurbits—Cucumber, melons, gourds, pumpkin and squashes.
Unit IV
Tuber crops—Sweet potato, elephant foot yam, tapioca, taro and yam.
Unit V
Leafy vegetables—Amaranth and drumstick**.**

Practical

- Scientific raising of nursery and seed treatment;• Sowing, transplanting, vegetable grafting;
- Description of commercial varieties and hybrids;
- Demonstration on methods of irrigation, fertilizers and micronutrients application;
- Mulching practices, weed management;
- Use of plant growth substances in warm season vegetable crops;
- Study of nutritional and physiological disorders;
- Studies on hydroponics, aeroponics and other soilless culture;
- Identification of important pest and diseases and their control;
- Preparation of cropping scheme for commercial farms;
- Visit to commercial farm, greenhouse/ polyhouses;
- Visit to vegetable market;
- Analysis of benefit to cost ratio.

Suggested Reading

- Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. *Vegetable crops*. Vols. I-III. Naya udyog.
- Bose TK, Som MG and Kabir J. (Eds.). 1993. *Vegetable crops*. Naya prokash.
- Chadha KL and Kalloo G. (Eds.). 1993-94. *Advances in horticulture* Vols. V-X. Malhotra publ. house.

- Chadha KL. (Ed.). 2002. *Hand book of horticulture*. ICAR.
- Chauhan DVS. (Ed.). 1986. *Vegetable production in India*. Ram prasad and sons.
- Fageria MS, Choudhary BR and Dhaka RS. 2000. *Vegetable crops: production technology*. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. *Vegetable crops*. New India publ. agency.
- Hazra P and Banerjee MK and Chattopadhyay A. 2012. *Varieties of vegetable crops in India*, (Second edition), Kalyani publishers, Ludhiana, 199 p.
- Hazra P. 2016. *Vegetable science*. 2nd edn, Kalyani publishers, Ludhiana.
- Hazra P. 2019. *Vegetable production and technology*. New India publishing agency, New Delhi.
- Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. *Modern technology for vegetable production*, New India publishing agency, New Delhi, 413p
- Rana MK. 2008. *Olericulture in India*. Kalyani Publishers, New Delhi.
- Rana MK. 2008. *Scientific cultivation of vegetables*. Kalyani Publishers, New Delhi.
- Rubatzky VE and Yamaguchi M. (Eds.). 1997. *World vegetables: principles, production and nutritive values*. Chapman and Hall.
- Saini GS. 2001. *A text book of oleri and flori culture*. Aman publishing house.

Salunkhe DK and Kadam SS. (Ed.). 1998. *Hand book of vegetable science*

(Hort-505) Tropical Fruit Production 3(2+1)

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

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.

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 of following crops.

Unit I:

Mango and Banana.

Unit II:

Guava and Pineapple.

Unit III:

Papaya and Avocado.

Unit IV:

Jackfruit and Annonas

Unit V:

Aonla and Ber

Practicals:

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

Suggested Reading

- Bartholomew DP, Paull RE and Rohrbach KG. 2002. *The Pineapple: Botany, Production, and Uses.* CAB International.
- Bose TK, Mitra SK and Sanyal D. 2002. *Fruits of India – Tropical and Sub-Tropical*.3rd Edn. Naya Udyog, Kolkata.
- Dhillon WS. 2013. *Fruit Production in India.* Narendra Publ. House, New Delhi.
- Iyer CPA and Kurian RM. 2006. *High Density Planting in Tropical Fruits: Principlesand 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 K 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.

(Horti-506) Commercial Production Technology of cut and loose flowers 3(2+1)

Theory

Scope and scenario: National and International scenario, importance and scope of cut flower trade, constraints for cut and loose flower production in India.

Growing environment: Soli analysis, soil health card, Growing environment, open cultivation, protected cultivation, soil/ media requirements, land preparation, planting methods, influence of light, temperature, moisture, humidity and microclimate management on growth and flowering.

Crop management: Commercial Flower production – Commercial varieties, water and nutrient management, fertigation, weed management, crop specific practices, ratooning, training and pruning, pinching, deshooting, bending, desuckering, disbudding. Use of growth regulators, physiological disorders and remedies, IPM and IDM.

Flower regulation: Flower forcing and year round/ offseason flower production through physiological interventions, chemical regulation, environmental manipulation.

Post harvest management: Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, storage and transportation. Marketing, export potential, institutional support, Agri Export Zones, 100% Export Oriented units, Crop Insurance.

Cut Flower Crops

Unit I:

Rose, chrysanthemum, gladiolus, tuberose, carnation, gerbera, orchids, lilium, anthurium, china aster, alstroemeria

Unit II:

Bird of paradise, heliconia, alpinia, ornamental ginger, dahlia, gypsophila, solidago, limonium, stock, cut greens and fillers.

Loose Flower Crops

Unit III:

Rose, jasmine, chrysanthemum, marigold, tuberose, china aster

Unit IV:

Crossandra, gaillardia, spider lily, hibiscus, nerium, barleria, celosia, gomphrena, Madar (Calotropis gigantea)

Unit V:

Nyctanthes (Harsingar), tabernaemontana (Chandni), lotus, water lily, michelia

Champa), gardenia, ixora and balsam

Practical

- Identification of varieties
- Commercial propagation in cut and loose flower crops
- Training and pruning techniques
- Pinching, deshooting, disbudding, desuckering
- Practices in manuring, drip and fertigation, foliar nutrition, growth regulator application
- Harvesting techniques, post-harvest handling, cold chain
- Economics, Project preparation for regionally important cut flowers, crop specific guidelines for project financing (NHB guidelines)
- Visit to commercial cut flower & loose flower units

Suggested Reading

- Arora JS. 2010. *Introductory Ornamental Horticulture*. Kalyani Publishers. 6th edition, pp. 230.
- Bhattacharjee SK. 2018. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ. Reprint, pp. 2065.
- Bose TK, Maiti, RG, Dhua RS and Das P. 1999. *Floriculture and Landscaping*. Prokash, Kolkata, India.
- Bose TK and Yadav LP. 1989. *Commercial Flowers*. Naya Prokash, Kolkata, India.
- Chadha KL and Bhattacharjee SK. 1995. *Advances in Horticulture: Ornamental Plants.* Vol. XII, Parts 1 & 2. pp. 533, pp. 574. Malhotra Publ. House, New Delhi, India.
- Chadha KL and Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR, New Delhi, India.
- Dole JM and Wilkins HF. 2004. *Floriculture-Principles and Species*. Prentice Hall. 2nd edition, pp. 1048.
- Larson RA. 1980. *Introduction to Floriculture*. New York Academic Press. pp. 628.
- Laurie A and Rees VH. 2001. *Floriculture-Fundamentals and Practices*. Agrobios Publications, Jodhpur. pp.534.
- Prasad S and Kumar U. 2003. *Commercial Floriculture*. Agrobios Publications, Jodhpur.

Randhawa GS and Mukhopadhyay A. 2001. *Floriculture in India*. Allied Publ. pp 660.

(AST 502) Data Analysis Using Statistical Packages 3(2+1)

Theory

Unit I

Introduction to various statistical packages: Excel, R, SAS, SPSS. Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis.

Unit II

Test for normality; Testing of hypothesis using chi-square, t and F statistics and-Ztest.

Unit III

Data preparation for ANOVA and ANCOVA, Factorial Experiments, contrast analysis, multiple comparisons, Analyzing crossed and nested classified designs.

Unit IV

Analysis of mixed models; Estimation of variance components; Correlation and regression analysis, Probit, Logit and Tobit Models.

Unit V

Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Neural networks.

Practical

- Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data
- Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for
- large samples - Chi-squares test, F test, one-way analysis of variance;
- Designs for Factorial Experiments, fixed effect models, random effect models, mixed
- effect models, estimation of variance components;
- Linear regression, Multiple regression, Regression plots
- Discriminant analysis - fitting of discriminant functions, identification of important
- variables
- Factor analysis. Principal component analysis - obtaining principal component.

Suggested Reading

- Anderson C.W. and Loynes R.M. 1987. The Teaching of Practical Statistics. John Wiley.
- Atkinson A.C. 1985. Plots Transformations and Regression. Oxford University Press.
- Chambers J.M., Cleveland W.S., Kleiner B and Tukey P.A. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmont, California.
- Chatfield C. 1983. Statistics for Technology. 3rd Ed. Chapman & Hall. Chatfield C. 1995. Problem Solving: A Statistician's Guide. Chapman & Hall.
- Cleveland W.S. 1985. The Elements of Graphing Data. Wadsworth, Belmont, California.
- Ehrenberg ASC. 1982. A Primer in Data Reduction. John Wiley.
- Erickson B.H. and Nosan Chuk T.A. 1992. Understanding Data. 2nd Ed. Open University Press, Milton Keynes.
- Snell E.J. and Simpson HR. 1991. Applied Statistics: A Handbook of GENSTAT Analyses. Chapman and Hall.
- Sprent P. 1993. Applied Non-parametric Statistical Methods. 2nd Ed. Chapman & Hall.
- Tufte ER. 1983. The Visual Display of Quantitative Information. Graphics Press, Cheshire, Conn.
- Velleman PF and Hoaglin DC. 1981. Application, Basics and Computing of Exploratory Data Analysis. Duxbury Press.
- Weisberg S. 1985. Applied Linear Regression. John Wiley.
- Wetherill GB. 1982. Elementary Statistical Methods. Chapman & Hall.

(PGS 503)- Agricultural Research, Research Ethics and Rural Development Programmes 1 (1+0)

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;

UNIT II

Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (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 III

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

UNIT IV

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.

UNIT V

Critical evaluation of rural development policies and Programmes. Constraints in implementation of rural policies and Programmes.

Suggested Readings

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

(PGS 504)-Library and Information Services 1(0+1)

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.

2nd Year (3rd Semester)

(Hort-507) Propagation and Nursery Management of Horticulture crops 3(2+1)

Theory:
UNIT-I

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.

UNIT-II
Propagation
Cutting and Layering– 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.

UNIT-III
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-IV
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.

UNIT-V
Nursery : 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.

Practical

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

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 PropagationPrinciples 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.

(Hort-508) Commercial Production Technology of Plantation, Medicinal, Aromatic and Spice crops 3(2+1)

Theory:

Area, production, productivity: Indian and world scenario: Role of plantation and spice crops in national economy, area-production statistics at national and international level, productivity challenges, industrial requirement of plantation and spice crops, demand-supply scenario of plantation and spice crop. Export potential: Export scenario, market opportunities and challenges in plantation and spice crops, global imports and exports, export of organic produce and products. Promotional programmes: Role of commodity boards and directorates in the development programmes of plantation and spice crops, contract farming, Farmer Producer Organizations (FPO) and Farmer Producer \ Companies (FPC).

Advanced Agrotechniques

Varietal wealth and planting material production: Cultivars and improved varieties in plantation and spice crops, mass multiplication techniques, hi-tech nursery techniques. Agrotechniques: Precision farming techniques, HDP systems, fertigation, chemical regulation of crop productivity, protected cultivation of high value crops, mechanization in plantation and spice crops, hydroponics, aeroponics, application of nanotechnology, robotics. Impact of climate change: Impact of biotic and abiotic factors on growth and productivity, climate resilient technologies in plantation and spice Crops, soil health management, organic production systems.

Harvest and postharvest management

Maturity indices and harvest: Influence of pre and post harvest factors on quality of plantation and spice crops, pre and post harvest management techniques for improving quality, good manufacturing practices in plantation and spice sector. Quality standards: Domestic and international standards, HACCP, BIS standards, domestic and export grades, modern packaging techniques, export protocols.

UNIT-I

Plantation Crops:

Coconut, Arecanut, Oil palm, Cashew, Coffee, Tea, Cocoa, Rubber, Palmyrah,

UNIT-II

Spice Crops:

Black pepper, small and large Cardamom, Turmeric, Ginger, Garlic, Coriander, Fenugreek, Cumin, Fennel, Ajwain, Saffron, Vanilla, Nutmeg, Clove, Cinnamon, Allspice, Tamarind and Garcinia.

Area, production and productivity statistics: Role of medicinal and aromatic crops in national economy, area-production statistics at national and international level, productivity challenges, Trends in food, flavouring, perfumery and cosmetic industries, requirement in the ayurvedic, pharmaceutical, perfume and cosmetic industries, demand-supply scenario of MAPs.

Agro techniques:

Advanced research in the field of growth and development, nutrition and irrigation requirements, inter culture, mulching, weed control. Precision farming techniques, HDP systems, fertigation, chemical regulation of crop productivity, protected cultivation of high value crops, hydroponics, aeroponics, application of nanotechnology, Nano- fertilizers, Nano-pesticides, robotics.

Maturity indices and harvest: Influence of pre and post-harvest factors on quality of medicinal and aromatic crops, pre and post-harvest management techniques for improving quality, good manufacturing practices in herbal sector.

Modern methods of extraction of MAPs: Advanced essential oil extraction and value addition methods in aromatic plants, advances in phytochemical extraction technologies, separation of bio-molecules,phytochemicals and drug development. Pharmacology and pharmacognosy, in vivo and in-vitro extraction of secondary metabolites, bioreactors.

Quality standards: Quality standards in medicinal and aromatic plants, quality standards in crude drugs and finished products, use of aroma chemicals, aroma therapy, advanced research in biomedicines, nutraceuticals and natural drugs, American, European and Asian legislations on plant drugs, domestic and international standards, modern packaging techniques

UNIT-III:

Coleus, Glory lily, Senna, Periwinkle, Stevia, Aswagandha,Sarpagandha, Aloe, Phyllanthus amarus, Andrographis paniculata, Isabgol and Poppy

UNIT-IV:

Digitalis sp., Commiphora sp., Ipecac, Henbane, Ocimum sp., Centella, Bacopa, Saraca, Valerian, Jatamansi, Aconits, Ephedra and Bael.

UNIT-V:

Palmarosa, Lemongrass, Citronella, Vetiver, Geranium, Artemisia, Mint, Eucalyptus, Rosemary, Thyme, Patchouli, Rose, Jasmine and Lavender

Practical

- Identification of seeds and plants;
- Botanical description of plant;
- Varietal features;
- Planting material production;
- Field layout and method of planting;
- Cultural practices;
- Harvest maturity, harvesting;
- Drying, storage, packaging;
- Primary processing; GAP in Plantation, Medicinal, Aromatic and Spice crops.
- Short term experiments on spice crops;
- Exposure visits to spice farms, research institutes.

Suggested Reading

- Agarwal S, Sastry EVD and Sharma RK. 2001. *Seed Spices: Production, Quality, Export.* Pointer Publ.
- Arya PS. 2003. *Spice Crops of India.* Kalyani.
- Bose TK, Mitra SK, Farooqi SK and Sadhu MK. Eds. 1999. *Tropical Horticulture.* Vol.I. Naya Prokash.

- Chadha KL and Rethinam P. Eds. 1993. *Advances in Horticulture.* Vols. IX-X. *Plantation Crops and Spices.* Malhotra Publ. House.
- Gupta S. Ed. *Hand Book of Spices and Packaging with Formulae.* Engineers India Research Institute, New Delhi.
- Ramachandra *et al.* 2018. *Breeding of Spices and Plantation crops*. Narendra Publishing House, New Delhi.
- Ravindran PN. 2000. *Black pepper, Piper nigrum*. CRC press.
- Ravindran PN. 2002. *Cardamom, the genusElettaria*. CRC press
- Ravindran PN. 2003. *Cinnamon and cassia.* CRC press
- Ravindran PN. 2004. *Ginger, the genus Zingiber*. CRC press
- Ravindran PN. 2007. *Turmeric, the genus curcuma*. CRC press
- Ravindran PN. 2017. *The Encyclopedia of Herbs and Spices*. CABI
- Shanmugavelu KG, Kumar N and Peter KV. 2002. *Production Technology of Spices and Plantation Crops.* Agrobios.
- Sharangi AB, Datta S and Deb P. 2018. Spices "*Agrotechniques for quality produce*". Apple Acadamic Press (Tylor and Francis Groups), New Jersey, USA.
- Barche S. 2016. *Production technology of spices, aromatic, medicinal and plantation crops*. New India Publishing Agency, New Delhi.
- Das K. 2013. *Essential oils and their applications*. New India Publishing Agency, New Delhi
- Farooqi AA and Sriram AH. 2000. *Cultivation Practices for Medicinal and Aromatic Crops*. Orient Longman Publ.
- Farooqi AA, Khan MM and Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops.* Natural Remedies Pvt. Ltd.
- Gupta RK. 2010. *Medicinal and Aromatic plants*. CBS publications.
- Hota D. 2007. *Bio Active Medicinal Plants*. Gene Tech Books. Jain SK. 2000. *Medicinal Plants.* National Book Trust.
- Khan IA and Khanum A. 2001. *Role of Biotechnology in Medicinal and Aromatic Plants*. Vol. IX. Vikaaz Publ.
- Kurian A and Asha Sankar M. 2007. *Medicinal Plants.* Horticulture Science Series, New India Publ. Agency.
- 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.
- Ponnuswami *et al.* 2018. *Medicinal Herbs and Herbal Cure*. Narendra Publishing House, New Delhi.
- Prajapati SS, Paero H, Sharma AK and Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios.

(Horti 509) Breeding of Horticulture Crops 2(1+1)

I. Theory

Unit I

Importance and history- Importance, history and evolutionary aspects of horticulture breeding and its variation from cereal crop breeding.

Unit II

Selection procedures- Techniques of selfing and crossing; Breeding systems and methods; Selection procedures and hybridization; Genetic architecture; Breeding for biotic stress

(diseases, insect pests and nematode), abiotic stress (temperature, moisture and salt) resistance and quality improvement; Breeding for water use efficiency (WUE) and nutrients use efficiency (NUE).

Unit III

Heterosis breeding- Types, mechanisms and basis of heterosis, facilitating mechanisms like male sterility, self-incompatibility and sex forms.

Unit IV

Mutation and Polyploidy breeding; Improvement of asexually propagated horticultural crops and vegetables suitable for protected environment.

Unit V

Ideotype breeding- Ideotype breeding; varietal release procedure; DUS testing in horticulural crops; Application of *In-vitro* and molecular techniques in horticultural crops improvement.

Crops

Rose, chrysanthemum, carnation, gerbera, gladiolus, orchids, anthurium, lilium, marigold, jasmine, tuberose, dahlia, gaillardia, crossandra, aster, etc., Flowering annuals: petunia, zinnia, snapdragon, stock, pansy, calendula, balsam, dianthus, etc. Important ornamental crops like aglaonema, diffenbachia, hibiscus, bougainvillea, kalanchoe, etc.

Crops

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

Practical

- Floral biology and pollination behaviour of different vegetables and ornamental crops;
- Techniques of selfing and crossing of different vegetables, viz., Cole crops, okra,cucurbits, tomato, eggplant, hot pepper, etc.;
- Selfing and crossing procedures for important ornamental crops (2);
- Breeding system and handling of filial generations of different vegetables;
- Exposure to biotechnological lab practices;
- Visit to breeding farms.

Suggested Reading

- Allard RW. 1960. *Principle of plant breeding*. John Willey and Sons, USA.
- Kalloo G. 1988. *Vegetable breeding* (Vol. I, II, III). CRC Press, Fl, USA.
- Kole CR. 2007. *Genome mapping and molecular breeding in plants-vegetables*. Springer, USA. Peter KVand Pradeep Kumar T. 1998. Genetics and breeding of vegetables. ICAR, New Delhi, p. 488.
- Prohens J and Nuez F. 2007. *Handbook of plant breeding-vegetables* (Vol I and II). Springer, USA.
- Singh BD. 2007. *Plant breeding- principles and methods* (8th edn.). Kalyani Publishers, New Delhi.
- Singh Ram J. 2007. *Genetic resources, chromosome engineering, and crop improvement-vegetable crops* (Vol. 3). CRC Press, Fl, USA. 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

(PGS 505) Technical Writing and Communications Skills 1(0+1)

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

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

4th Semester

(HORT 510)	**Master Seminar**	**1(0+1)**
(HORT- 511 A)	**Master Research (Thesis)**	**30**

Or

(HORT- 511 B) IDEA (Internship for Development of Entrepreneurship In Agriculture) 30