

# SIKKIM UNIVERSITY

*(A Central University Established by an Act of Parliament of India, 2007)*

## LEARNING OUTCOME - BASED CURRICULUM

### MASTERS' PROGRAMMES IN HORTICULTURE

#### Msc (Horticulture)

(With effect from Academic Session 2023-24)



### DEPARTMENT OF HORTICULTURE

SIKKIM UNIVERSITY

6<sup>TH</sup> MILE, TADONG - 737102

GANGTOK, SIKKIM, INDIA





## VICE-CHANCELLOR'S MESSAGE

Sikkim University stands at the forefront of embracing the transformative National Education Policy (NEP) 2020. In alignment with NEP 2020's vision and the guidelines of the Learning Outcomes-based Curriculum Framework (LOCF) mandated by the UGC, we have undertaken a comprehensive revision of our curriculum across all departments. This initiative ensures a holistic educational experience that transcends traditional knowledge delivery, emphasizing the practical application of knowledge in real-world scenarios. The shift towards LOCF marks a pivotal change from teacher-centric to learner-centric education, fostering a more active and participatory approach to learning. Our updated curriculum clearly defines Graduate Attributes, Programme Learning Outcomes (PLOs), and Course Learning Outcomes (CLOs), setting clear objectives for our students to achieve. This revision is designed to enable a teaching-learning environment that supports the attainment of these outcomes, with integrated assessment methods to monitor and encourage student progress comprehensively.

A key innovation in our curriculum is the mandatory integration of Massive Open Online Courses (MOOCs) through the SWAYAM platform, enhancing accessibility and the breadth of learning opportunities for students. Our approach encourages multidisciplinary studies through the curriculum while allowing for specialization. The curriculum embodies the policy's core principle of flexibility by enabling mobility for students, thereby allowing the exit and entry of students in the program.

I extend my heartfelt gratitude to our faculty, the Head of the Department, the Curriculum Development Committee members, the NEP coordinators, and the dedicated NEP Committee of Sikkim University for their relentless dedication to updating our curriculum. I appreciate Prof. Yodida Bhutia, the Chairperson, and all dedicated NEP Committee members for their thorough review and integration of LOCF and NEP components into our curriculum.

To our students, I convey my best wishes as we embark on this journey with our updated and inclusive curriculum, aiming not only to enrich their academic knowledge but also to nurture their personal growth, critical thinking, and ability to adapt and innovate in an ever-changing world.

Best wishes,



Prof. Avinash Khare  
Vice Chancellor  
Sikkim University



## PREAMBLE

MSc Horticulture programme is envisaged in four specializations viz, Fruit Science, Vegetable Science, Floriculture and Landscaping, and Plantation, Spices, Medicinal, and Aromatic Crops. The syllabus in the existing MSc programme was expanded to meet the requirements of the four PG programmes. The basic philosophy of revision envisages increasing the basic science content, updating the overall content in view of globalized economy, imbibing technologies from developed countries, compliance to National and International laws in respect of food quality, standards, specifications, and use of ICT in Horticulture Education.

## POSTGRADUATE ATTRIBUTES

The post graduates should have:

PGA 1: Disciplinary knowledge and understanding

PGA2: Research related Skills

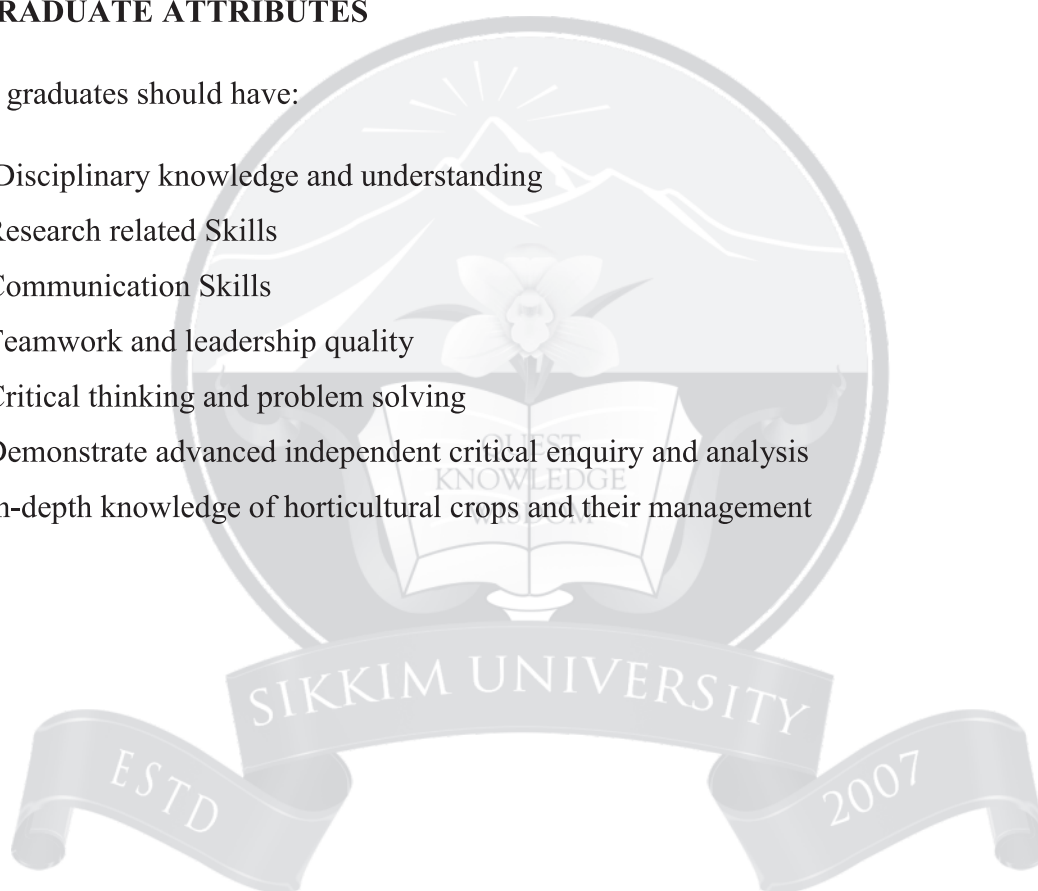
PGA3: Communication Skills

PGA4: Teamwork and leadership quality

PGA5: Critical thinking and problem solving

PGA6: Demonstrate advanced independent critical enquiry and analysis

PGA7: In-depth knowledge of horticultural crops and their management



**PROGRAMME LEARNING OUTCOMES****PL01: Knowledge**

At the end of the programme the students will have an expertise in:

1. Management of fruit crops, biotechnology, biodiversity conservation, organic production, GAP in fruit cultivation, and post harvest technology.
2. High tech. floriculture, protected cultivation, management of major flower crops grown in India, Turfing and turf management, concept of landscaping, gardens, their layout, and CAD operations.
3. Crop improvement and management of vegetable crops grown in India.
4. Precision farming, biotechnology, organic production, and GAP in vegetable cultivation
5. Management, crop improvement, and post harvest processing of plantation crops, spices, medicinal and aromatic crops.
6. Illustrate the various laboratory techniques and its application in the horticulture field.
7. Understand the horticulture sector in India specifically and in the world generally.

**PLO2: Cognitive Skill**

At the end of the programme the students will be able to:

1. Design and conduct research experiments.
2. Analyze data, interpret results, and prepare reports on the research conducted.
3. Communicate effectively through written exams, reports, presentations, and participate in discussions.
4. Develop life long learning skills and scientific approach to conduct research related problems in Horticultural fields.

**PLO3: Interpersonal Skill and Responsibility**

At the end of the programme the students will be able to:

1. Participate and discuss with experts in workshops and seminars.
2. Organize and act as coordinator between members of team.
3. Communicate effectively.
4. Trained in the management and improvement of fruit crops, vegetable crops, major flower crops, and medicinal, aromatic, and plantation crops.
5. Handle operation of CAD, SPSS, Excel, and other relevant ICT tools.

**PLO4 : Communication, Information Technology, Numerical**

At the end of the programme, the students will be able to:

1. Perform research work, collect data, prepare presentations, communicate effectively, analyze data, and write the thesis.
2. Demonstrate communication skills such as writing, reading, presenting, and debating.
3. Demonstrate skills in usage of computer, networks, software packages relevant to agriculture research analysis.



**ORGANIZATION OF COURSS & CREDIT**  
**REQUIREMENTS FOR MASTER'S IN HORTICULTURE**

**Credit Requirements**

<b>Subject</b>	<b>Credit Allotted</b>
Major	21
Minor	09
Supporting courses	06
Common compulsory courses	05
Seminar	01
Value added course	06
Skill enhancement courses	04
Master's Research	30
<b>Total Credits</b>	<b>82</b>

**Major courses:** From the discipline/ specialization in which a student takes admission.

**Minor courses:** Students can opt for any specialization of Horticulture other than his/her major courses.

**Supporting courses:** The subject is not related to the major subject. It could be any subject considered relevant for the student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

**Common Compulsory Courses:** The following courses (one credit each) will be offered to all students undergoing the Master's degree program:

1. Library and Information Services
2. Technical Writing and Communications Skills
3. Intellectual Property and its management in Agriculture
4. Basic Concepts in Laboratory Techniques
5. Agricultural Research, Research Ethics, and Rural Development Programmes

**NEP compulsory courses:** As per NEP guidelines, Indian Traditional Knowledge, Cyber Security, and Skill Enhancement are common compulsory courses for any Master's degree.

**Master's Research/ Thesis:** Master's research is 30 credits, which will be offered over last two semesters. In 3<sup>rd</sup> semester 10 credits of Master's research will be allocated. Rest of the 20 credits will be allocated in the 4<sup>th</sup> semester.

## Program Structure

Code	Course Title	Credits L+T+P	Semester
<b>Major courses specialization wise</b>			
<b>Fruit Science</b>			
HOR-C-501	Tropical Fruit Production	2+0+1	II
HOR-C-502	Sub-Tropical and Temperate Fruit Production	2+0+1	II
HOR-C-503	Propagation and Nursery Management of Fruit Crops	2+0+1	II
HOR-C-504	Breeding of Fruit Crops	2+0+1	II
HOR-C-505	Organic Fruit Culture	2+0+1	III
HOR-C-506	Nutrition of Fruit Crops	2+0+1	III
HOR-C-507	Minor Fruit Production	2+0+1	III
<b>Vegetable Science</b>			
HOR-C-511	Production of Cool Season Vegetable Crops	2+0+1	II
HOR-C-512	Production Technology of Warm Season Vegetable Crops	2+0+1	II
HOR-C-513	Growth and Development of Vegetable Crops	2+0+1	II
HOR-C-514	Principles of Vegetable Breeding	2+0+1	II
HOR-C-515	Breeding of Self-pollinated Vegetable Crops	2+0+1	III
HOR-C-516	Breeding of Cross-pollinated Vegetable Crops	2+0+1	III
HOR-C-517	Seed production of Vegetable Crops	2+0+1	III
<b>Floriculture &amp; Landscaping</b>			
HOR-C-521	Systematics of Ornamental Plants	2+0+1	II
HOR-C-522	Commercial Production of Cut Flowers	2+0+1	II
HOR-C-523	Commercial Production of Loose Flowers	2+0+1	II
HOR-C-524	Breeding of Ornamental Plants	2+0+1	II
HOR-C-525	Ornamental Gardening and Landscaping	2+0+1	III
HOR-C-526	Turf Grass Management	2+0+1	III
HOR-C-527	CAD for Landscaping	2+0+1	III
<b>Plantation, Spices, Medicinal and Aromatic plants</b>			
HOR-C-531	Production of Plantation Crops	2+0+1	II
HOR-C-532	Production of Spices Crops	2+0+1	II
HOR-C-533	Production of medicinal and Aromatic Crops	2+0+1	II
HOR-C-534	Biochemistry of Plantation, Spices, Medicinal, and Aromatic Crops	2+0+1	II
HOR-C-535	Breeding of Plantation and Spices Crops	2+0+1	III
HOR-C-536	Breeding of Medicinal and Aromatic Crops	2+0+1	III



HOR-C-537	Growth and Development of Plantation, Spices, Medicinal, and Aromatic Crops	2+0+1	III
<b>Common Supporting Courses for all students</b>			
HOR-SU-541	Experimental Designs	2+0+1	I
HOR-SU-542	Biotechnology for Crop Improvement	2+0+1	I
<b>Common Compulsory Courses for all students</b>			
HOR-CC-551	Intellectual Property and Its Management in Agriculture	1+0+0	I
HOR-CC-552	Basic Concepts in Laboratory Techniques	0+0+1	I
HOR-CC-553	Library and Information Services	0+0+1	I
HOR-CC-554	Technical Writing and Communications Skills	0+0+1	I
HOR-CC-555	Agricultural Research, Research Ethics, and Rural Development Programmes	1+0+0	I
HOR-V-556	Indigenous Traditional Knowledge in Horticulture	4+0+0	I
HOR-V-557	Cyber security and privacy	2+0+0	I
HOR-S-558	Value addition of Horticultural Crops (Skill Enhancement I)	1+0+1	I
HOR-S-559	Diagnosis of disease and identification of insect-pest in Horticulture crops (Skill Enhancement II)	1+0+1	I
<b>Research</b>			
HOR-C-591	Master's Seminar	0+0+1	III
HOR-R-599-I	Master's Research-I	0+0+10	III
HOR-R-599-II	Master's Research –II	0+0+20	IV

A student majoring in Horticulture has to select any one subject specialization i.e. Fruits Science/ Floriculture & Landscaping/ Vegetable Science/ Plantation, Spices, Medicinal & Aromatic Plants and all the courses of concerned specialization are compulsory.

He/She can opt for any other specialization courses as minor. All the students have to take compulsory supportive courses.

### **Semester-wise credit distribution**

<b>Semester</b>	<b>Credits</b>
First	21 (06 Supporting + 05 Compulsory+ 04 ITK + 02 Cyber Security + 04 Skill Enhancement)
Second	21 (12 Major + 9 Minor)
Third	20 (09 Major + 01 Seminar + 10 Master's Research)
Fourth	20 (Master's Research)
<b>Total Credits</b>	<b>82</b>



**COURSES DETAIL****SUPPORTING COURSES****HOR-SU-541 EXPERIMENTAL DESIGNS****Semester: First Semester****Total Marks: 100****L+T+P: 2+0+1 = 3    Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course Learning Outcomes**

On completing the course, the students will be able to:

CLO1: Understand the basics of statistics

CLO2: Learn different experimental designs

CLO3: Analyse different tests and statistical designs

CLO4: Apply different statistical tests and designs for data analysis and interpretation.

**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, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

**Unit IV**

Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

**Practical**

- Uniformity trial data analysis,
- Formation of plots and blocks,
- Exercises on probability distributions.
- Correlation and regression analysis.
- Large sample tests,
- Testing of hypothesis based on  $\chi^2$ , t, and F.
- Exercises on non-parametric tests.
- Fairfield Smith Law;
- Analysis of data obtained from CRD, RBD, LSD;
- Analysis factorial experiments without and with confounding;
- Analysis with missing data; Split plot and strip plot designs;
- Transformation of data; Analysis of resolvable designs;
- Fitting of response surfaces.

**Suggested Teaching Learning Strategies**

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,
- Reflective Writing Comparative Analysis,
- Individual and group presentations by students on selected themes.

**Assessment Framework**

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

**Suggested Readings**

- Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
- Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
- Federer WT. 1985. Experimental Designs. MacMillan.
- Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
- Nigam AK & 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.
- Design Resources Server: [www.iasri.res.in/design](http://www.iasri.res.in/design), 14.139.232.166/opstat

**HOR-SU-542 BIOTECHNOLOGY FOR CROP IMPROVEMENT****Semester: First Semester****Total Marks: 100****L+T+P: 2+0+1 = 3    Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course Learning Outcomes**

On completing the course, the students will be able to:

CLO1: Understand the principles, theoretical aspects, and developing skills in biotechnology of horticultural crops.

CLO2: Learn different methodology of tissue culture for horticulture crops.

CLO3: Analyse different techniques of *in-vitro* culture.

CLO4: Apply different techniques of DNA isolation, quantification and analysis.

**Theory****Unit I**

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.

Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

**Unit II**

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH).

**Unit III**

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding. Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

**Unit IV**

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, and physical methods of gene transfer. Production of transgenic plants in various horticultural crops and Commercial releases. MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs;

Regulatory procedures in major countries including India, ethical, legal, and social issues; Intellectual property rights. Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programs.

### Practical

- Requirements for plant tissue culture laboratory
- Techniques in plant tissue culture
- Media components and media preparation
- Aseptic manipulation of various explants
- Observations on the contaminants occurring in media
- Culture of explants
- Callus induction and plant regeneration
- Standardizing the protocols for regeneration
- Hardening of regenerated plants;
- Establishing a greenhouse and hardening procedures
- Visit to commercial micropropagation unit.
- Transformation using Agrobacterium strains,
- GUS assay in transformed cells / tissues.
- DNA isolation, DNA purity and quantification tests,
- Gel electrophoresis of proteins and isozymes,
- PCR-based DNA markers,
- Gel scoring and data analysis for tagging and phylogenetic relationship,
- Construction of genetic linkage maps using computer software.

### Suggested Teaching Learning Strategies

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,
- Reflective Writing Comparative Analysis,
- Individual and group presentations by students on selected themes.

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

**Suggested Readings**

- Chopra VL & Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methods and Applications. Oxford & IBH.
- Gupta PK. 1997. Elements of Biotechnology. Rastogi Publ.
- Hackett PB, Fuchs JA & Messing JW. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co.
- Sambrook J & Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.
- Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani.



## COMMON COMPULSORY COURSES

### HOR-CC-551 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

Semester: First Semester

Total Marks: 100

**L+T+P: 1+0+0 = 1    Credits Lecture: 15 Hrs + Tutorial: 0 Hrs + Practical: 0 Hrs**

#### Course Learning Outcomes

On completing the course, the students will be able to:

CLO1: Understand IPR-related protection systems.

CLO2: Learn IPR significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

#### Theory

##### Unit I

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

#### Suggested Teaching Learning Strategies

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,
- Reflective Writing Comparative Analysis,
- Individual and group presentations by students on selected themes.

#### Assessment Framework

Assessment	Written Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO



**Suggested Readings**

- Erbis F. Hand 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 Mand 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,1957and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

**HOR-CC-552 BASIC CONCEPTS IN LABORATORY TECHNIQUES****Semester: First Semester****Total Marks: 100****L+T+P: 0+0+1 = 1 Credits Lecture: 0 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course Learning Outcomes**

On completing the course, the students will be able to:

CLO1: Understand working and safety measures of a common laboratory.

CLO2: Learn the basics of commonly used techniques in the laboratory.

CLO3: Conduct basic laboratory analytical tests in horticulture.

CLO4: Apply different laboratory analytical techniques.

CLO5: Handle common laboratory instruments.

**Unit I (Practical)**

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micro pipettes and vascupets; Washing, drying and sterilization of glassware; Drying of solvents/chemicals; Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values; Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, 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 Teaching Learning Strategies**

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,
- Reflective Writing Comparative Analysis,
- Individual and group presentations by students on selected themes.

**Assessment Framework**

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments,	Oral Test, Viva-Voce, Class presentations, Field Assignments



	Home assignments, Report writing, Article writing	
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

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

## HOR-CC-553 LIBRARY AND INFORMATION SERVICES

**Semester: First Semester**

**Total Marks: 100**

**L+T+P: 0+0+1 = 1 Credits Lecture: 0 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs**

### Course Learning Outcomes

On completing the course, the students will be able to:

CLO1: Understand the library use with skills to trace information from libraries efficiently

CLO2: Apprise them of information and knowledge resources.

CLO3: formulate information search strategies.

CLO4: Apply modern tools (Internet, OPAC, search engines, etc.) of information search.

### Unit I (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.

### Suggested Teaching Learning Strategies

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,
- Reflective Writing Comparative Analysis,

- Individual and group presentations by students on selected themes.

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

## HOR-CC-554 TECHNICAL WRITING AND COMMUNICATION SKILLS

**Semester: First Semester**

**Total Marks: 100**

**L+T+P: 0+0+1 = 1 Credits Lecture: 0 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs**

### Course Learning Outcomes

On completing the course, the students will be able to:

CLO1: Understand the academic/scientific writing styles

CLO2: Learn skills to write dissertations, research papers, etc.

CLO3: Apply modern tools for scientific writing

### Unit I (Practical)

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 these 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 Teaching Learning Strategies

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,

- Reflective Writing Comparative Analysis,
- Individual and group presentations by students on selected themes.

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Barnes and Noble. Robert C. (Ed.).2005.Spoken English: Flourish Your Language.
- Chicago Manual of Style.14<sup>th</sup> Ed.1996.Prentice Hall of India.
- Collins' Cobuild English Dictionary.1995.
- Collins H, Gordon H M and Walter JA. 1970. Technical Writing. 3rdEd.
- Holt, Rinehart and Winston. HornbyAS.2000.Comp. Oxford Advanced Learner's Dictionary of Current English. 6thEd. OXford University Press.
- James H S.1994. Handbook for Technical Writing. N T C Business Books.
- Joseph G.2000. M L A Handbook for Writers of Research Papers. 5<sup>th</sup> Ed. Affiliated East-West Press.
- Mohan K. 2005. Speaking English Effectively. Mac Millan India.

**HOR-CC-555 AGRICULTURAL RESEARCH, RESEARCH ETHICS, AND RURAL DEVELOPMENT PROGRAMMES****Semester: First Semester****Total Marks: 100****L+T+P: 1+0+0 = 1 Credits Lecture: 15 Hrs + Tutorial: 0 Hrs + Practical: 0 Hrs****Course Learning Outcomes**

On completing the course, the students will be able to:

CLO1: Understand the organization and functioning of agricultural research systems at national and international levels.

CLO2: Learn research ethics and rural development programs and policies of Government.

**Theory****Unit I**

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

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

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 Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

**Suggested Teaching Learning Strategies**

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,
- Reflective Writing Comparative Analysis,
- Individual and group presentations by students on selected themes.

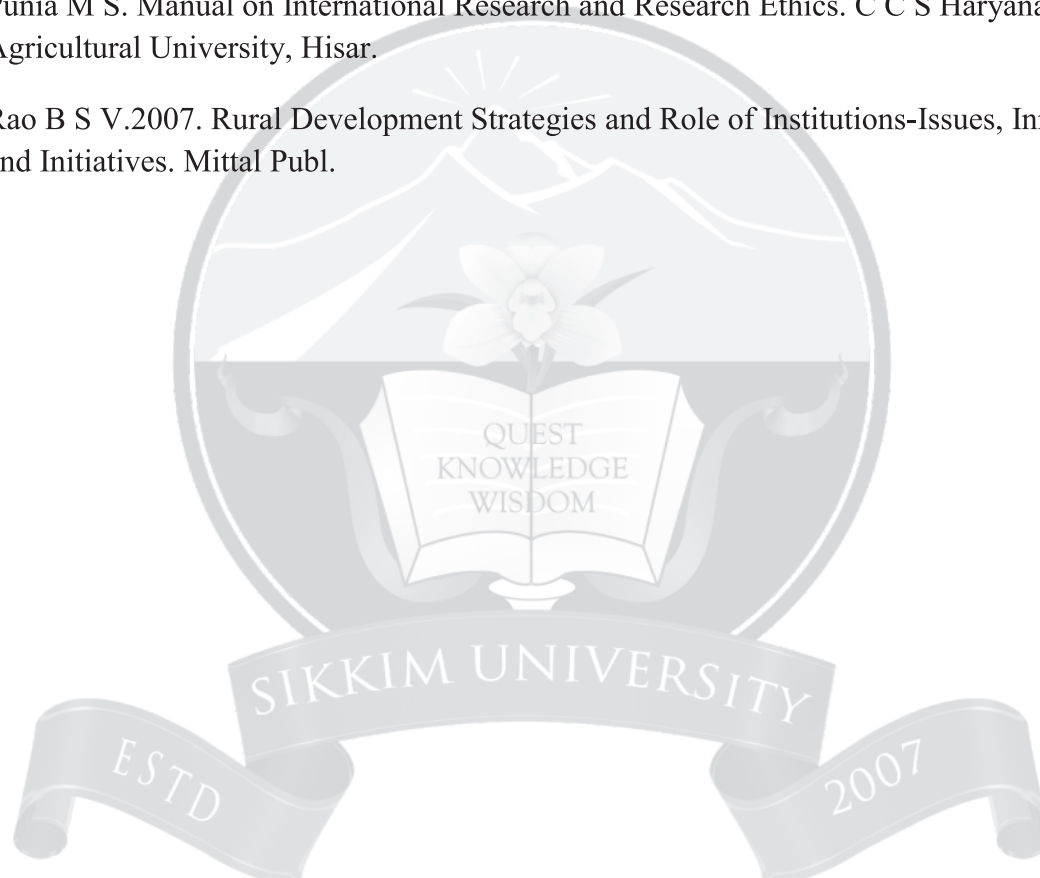
### Assessment Framework

Assessment	Written Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Bhalla G S and Singh G.2001. Indian Agriculture-Four Decades of Development. Sage Publ.
- Punia M S. Manual on International Research and Research Ethics. C C S Haryana Agricultural University, Hisar.
- Rao B S V.2007. Rural Development Strategies and Role of Institutions-Issues, Innovations and Initiatives. Mittal Publ.



**VALUE ADDED COURSE****HOR-V-556 INDIGENOUS TRADITIONAL KNOWLEDGE IN HORTICULTURE****Semester: First Semester****Total Marks: 100****L+T+P: 4+0+0 = 4****Credits Lecture: 60 Hrs + Tutorial: 0 Hrs + Practical: 0 Hrs****Course learning outcomes**

On completing the course, the students will be able to:

CLO1: Understand the Indian traditional knowledge of cultivation in horticulture

CLO2: Learn different methods of validation of the ITK

CLO3: Learn about the institutes working on the conservation and validation of ITK

CLO4: Analyse the contribution of ITK in the field of horticulture

CLO5: Apply different scientific methods for the validation of the ITK

CLO6: Evaluate the contribution of Indian in the field of Horticulture Science.

**Theory****Unit I**

Understanding of Indian Traditional Knowledge (ITK). Traditional knowledge in horticulture. Natural Farming and Organic Farming – principles, systems, components, and inputs.

**Unit II**

Traditional methods used for crop production: seed treatment, nutrient management, irrigation management, and insect, pest, disease, and weed management. Traditional methods for soil and water conservation, Traditional method vis-a-vis modern method.

**Unit III**

Assessment methods for ITK. Scientific validation of traditional systems – case studies. National and International research and other institutions involved in scientific validation of traditional knowledge eg. ICAR, Director of Research, CDRI, RRL's, etc., their role and major achievements.

**Unit IV**

IPR in ITK, Good Agriculture Practice (GAP), Indian contribution to horticulture in particular, and agriculture in general.



### Suggested Teaching Learning Strategies

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,
- Individual and group presentations by students on selected themes.

### Assessment Framework

Assessment	Written Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings:

- Chadha KL and Gupta R. 2006. Advances in Horticulture. Vol. I-XII.
- Chakravarty, A. (2004). Validation of Indigenous Technical Knowledge in Agriculture. Division of Agricultural Extension, ICAR, New Delhi.p.499
- Chakravarty, A. (2022). Inventory of Indigenous Technical Knowledge in Agriculture. Division of Agricultural Extension, ICAR, New Delhi.p.411
- Mishra, Anupam, Singh, S.R.K., Raut, A.A. (2020). Traditional Knowledge in Agriculture. Division of Agricultural Extension, ICAR, New Delhi. p.39
- Rajput Ajay Singh, Jariyal Monu, Singla Ankit (2018). Indigenous Technical Knowledge. Training Manual published on thirty day's certificate course on Organic Farming by Regional Centre on Organic Farming, Bhubaneswar. pp.1-37

**HOR-V-557 CYBER SECURITY AND PRIVACY****Semester: First Semester****Total Marks: 100****L+T+P: 2+0+0 = 2 Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 0 Hrs****Course Learning Outcomes**

On completing the course, the students will be able to:

CLO1: Understand the basics of security management, information security, and related risk management.

CLO2: Learn cyber security regulations, Cyber security, and privacy in the Indian context, evolution and issues.

CLO3: Evaluate choices on security and privacy.

**Theory****Unit I**

Foundations, cyber security, information security, and related concepts, Principles of information security management, Confidentiality, Integrity, Availability, and related concepts. Security management, Governance, Risk and Compliance (GRC), Contingency planning, incidence response, disaster recovery, and business continuity. Understanding security policy, security behaviour, Risk management: Risk identification, threat modeling, strategies.

**Unit II**

Control strategies and protection mechanisms, Cryptography for security. Regulatory landscape: EU's GDPR and its implications and other privacy and cyber security regulations, Cyber security and privacy in the Indian context, evolution, and issues. Information security and privacy, Regulatory landscape: Fair information practices, US regulatory frameworks. Economics of privacy, privacy calculus, and trade-offs, privacy paradox, managing stakeholders, making choices on security and privacy.

**Suggested Teaching Learning Strategies**

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,
- Individual and group presentations by students on selected themes.



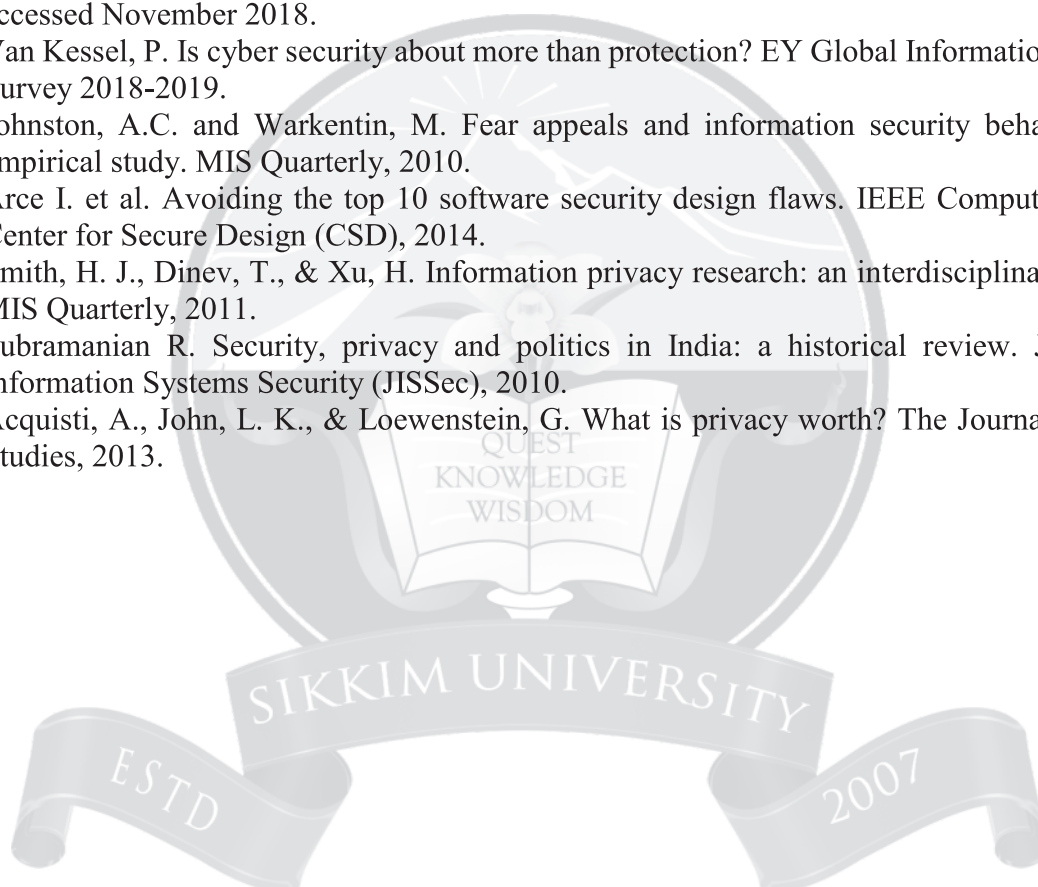
## Assessment Framework

Assessment	Written Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

## Suggested Reading:

- Michael E. Whitman, Herbert J. Mattord, 2018. Principles of Information Security, 6<sup>th</sup> edition, Cenage Learning, N. Delhi.
- Darktrace, “Technology” <https://www.darktrace.com/en/technology/#machine-learning>, accessed November 2018.
- Van Kessel, P. Is cyber security about more than protection? EY Global Information Security Survey 2018-2019.
- Johnston, A.C. and Warkentin, M. Fear appeals and information security behaviors: An empirical study. MIS Quarterly, 2010.
- Arce I. et al. Avoiding the top 10 software security design flaws. IEEE Computer Society Center for Secure Design (CSD), 2014.
- Smith, H. J., Dinev, T., & Xu, H. Information privacy research: an interdisciplinary review. MIS Quarterly, 2011.
- Subramanian R. Security, privacy and politics in India: a historical review. Journal of Information Systems Security (JISSec), 2010.
- Acquisti, A., John, L. K., & Loewenstein, G. What is privacy worth? The Journal of Legal Studies, 2013.



**SKILL ENHANCEMENT COURSES****HOR-S-558 VALUE ADDITION OF HORTICULTURE CROPS (SKILL ENHANCEMENT I)****Semester: First Semester****Total Marks: 100****L+T+P: 1+0+1 = 2****Credits Lecture: 15 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course learning outcomes:**

On completing the course, the students will be able to:

CLO1: Understand the value-addition process of horticulture crops.

CLO2: Learn different methods of value-addition of horticulture crops.

CLO3: Analyse the crops for the preparation of different value-added products.

CLO4: Apply different techniques for value-added product preparation.

**Theory****Unit I**

Value addition of Horticulture Crops: Major value-added fruits and vegetable products; Utilization of by-products of fruits and vegetable processing industry; Principles and methods of sensory evaluation of fresh and processed fruit and vegetable. Principles and practices of different types of extraction – distillation, solvent extraction, enfleurage, soxhlet, supercritical fluid extraction, photonics, counter-current extraction. Fresh and Dry flower arrangements, pigment and natural dyes extraction technology. Organic products: Enrichment of composts; Biofertilizers; Biocontrol agents; Biodynamic preparations; Zero-budget organic preparations; Biopesticides; AMF in organic production; Waste management techniques. Food standards- National, international, CODEX Alimentarius.

**Practical:**

- Practices in preparation of different types of flower arrangements including bouquets, button-holes, flower baskets, corsages, floral wreaths, and garlands with fresh flowers;
- Techniques in flower arrangement and floral decoration;
- Identification of plants for dry flower making;
- Practices in dry flower making; Preparation of dry flower baskets, bouquets, potpourri, wall hangings, buttonholes, greeting cards, wreaths, etc.;
- Essential oil extraction;
- Extraction of pigments;
- Preparation of different process products of local fruits and vegetable

- Sensory evaluation of fresh and processed vegetables

### Suggested Teaching Learning Strategies

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,
- Individual and group presentations by students on selected themes.

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings:

- Arthey D and Dennis C. 1996. Vegetable processing. Blackie/ Springer-Verlag.
- Bhattacharjee SK. 2018. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Reprint, pp. 2065.
- Chadha DS. 2006. The Prevention of food adulteration act. Confed. of Indian Industry.
- Chadha KL and Bhattacharjee SK. 1995. Advances in Horticulture: Ornamental Plants. Vol. XII, Parts 1 & 2. pp.533 and pp.574. Malhotra Publ. House, New Delhi, India.
- Desrosier NW. 1977. Elements and technology. AVI Publ. Co.
- FAO. 1997. Fruit and Vegetable processing. FAO.
- FAO. CODEX Alimentarius: Joint FAO/ WHO food standards programme. 2nd Ed. Vol. VB. tropical fresh fruits and vegetables. FAO.
- FAO. Food quality and safety systems- training manual on food hygiene and haccp. FAO.
- Fellow's P. 1988. Food processing technology. Ellis Horwood International.
- Frazier WC and Westhoff DC. 1995. Food microbiology. 4th Ed. Tata McGraw Hill.
- Giridharilal GS Siddappa and Tandon GL. 1986, Preservation of fruits and vegetables. ICAR.
- Gisela J. 1985. Sensory evaluation of food- theory and practices. Ellis Horwood.
- Graham HD. 1980. Safety of foods. AVI Publ. Co.
- Hildegrade H and Lawless HT. 1997. Sensory evaluation of food. CBS.
- Joslyn M and Heid Food processing operations. AVI Publ. Co.
- Lauria A and Victor HR. 2001. Floriculture-Fundamentals and Practices. Agrobios Publ., Jodhpur.
- Mahindru SN. 2004. Food safety: concepts and reality. APH Publ. Corp.
- Ranganna S. 1986. Handbook of analysis and quality control for fruit and vegetable products. 2nd Ed. Tata-McGraw Hill.
- Shapiro R. 1995. Nutrition labeling handbook. Marcel Dekker.

- Sharangi AB and Datta S. 2015. Value Addition of Horticultural crops: Recent trends and Future directions. SPRINGER; ISBN: 978-81-322-2261-3
- Srivastava RP and Kumar S. 2003. Fruit and vegetable preservation: principles and practices. 3<sup>rd</sup> Ed. International Book Distri. Co.
- Manoranjan, K and Sangita, S. 1996. Food Preservation & Processing. Kalyani Publishers, India.
- Siddappaa, G. S., Girdhari Lal and Tandon, G.L. 1998. Preservation of Fruits and Vegetables. ICAR, New Delhi



## **HOR-S-559    DIAGNOSIS OF DISEASES AND IDENTIFICATION OF INSECT-PESTS IN HORTICULTURE CROPS (SKILL ENHANCEMENT II)**

**Semester: First Semester**

**Total Marks: 100**

**L+T+P: 1+0+1 = 2    Credits Lecture: 15 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs**

### **Course learning outcomes:**

On completing the course, the students will be able to:

CLO1: Learn identification of insect pests of horticultural crops, their nature of damage, life history traits, and effective management.

CLO2: Develop an understanding of diseases of horticultural crops, their symptoms, and effective management.

CLO3: Learning of diagnostics tools for diseases through laboratory techniques

CLO4: Learning of mass multiplication of biocontrol agents

### **Theory**

#### **Unit I**

Distribution, biology, nature and symptoms of damage of insect and non-insect pests of horticultural crops. Identification of major parasitoids and predators commonly being used in biological control. Insect orders bearing predators and parasitoids used in pest control and their mass multiplication techniques. Important species of pollinators, weed killers, and scavengers with their importance. Plant protection in organic horticulture. Important plant pathogenic organisms (different groups): fungi, bacteria, phytoplasma, spiroplasma, viruses, viroids, algae, protozoa and phanerogamic plant parasites. Causes and factors affecting disease development: Disease triangle and tetrahedron and classification of plant diseases. Survey surveillance and forecasting of diseases. Calculation and dynamics of economic injury level and importance of Economic threshold level. Methods of control: Host plant resistance, cultural, mechanical, physical, legislative, and biological control. Components of Integrated Disease Management- their limitations and implications. Development of IDM-basic principles, biological, chemical, and cultural disease management.

### **Practical:**

- Identification and nature of damage of pests of horticultural crops;
- Methods of collection and preservation of important pests and their natural enemies including immature stages;
- Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, nematodes;
- Field visit for the diagnosis of field problems. Collection and preservation of pest and disease specimens for Herbarium;



- Detection of plant pathogens 1. Based on visual symptoms, 2. Biochemical test 3. Staining and identification of plant pathogens using microscopic techniques, 4. Cultural studies; (use of selective media to isolate pathogens). 5. Biological assays (indicator hosts, differential hosts)
- Determination of soil microbial population.
- Identification of biocontrol agents. Mass multiplication of *Trichoderma*, *Pseudomonas*, etc.

### Suggested Teaching Learning Strategies

- Lecture-cum discussion,
- Reading assignments,
- Critical discussion,
- Individual and group presentations by students on selected themes.

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

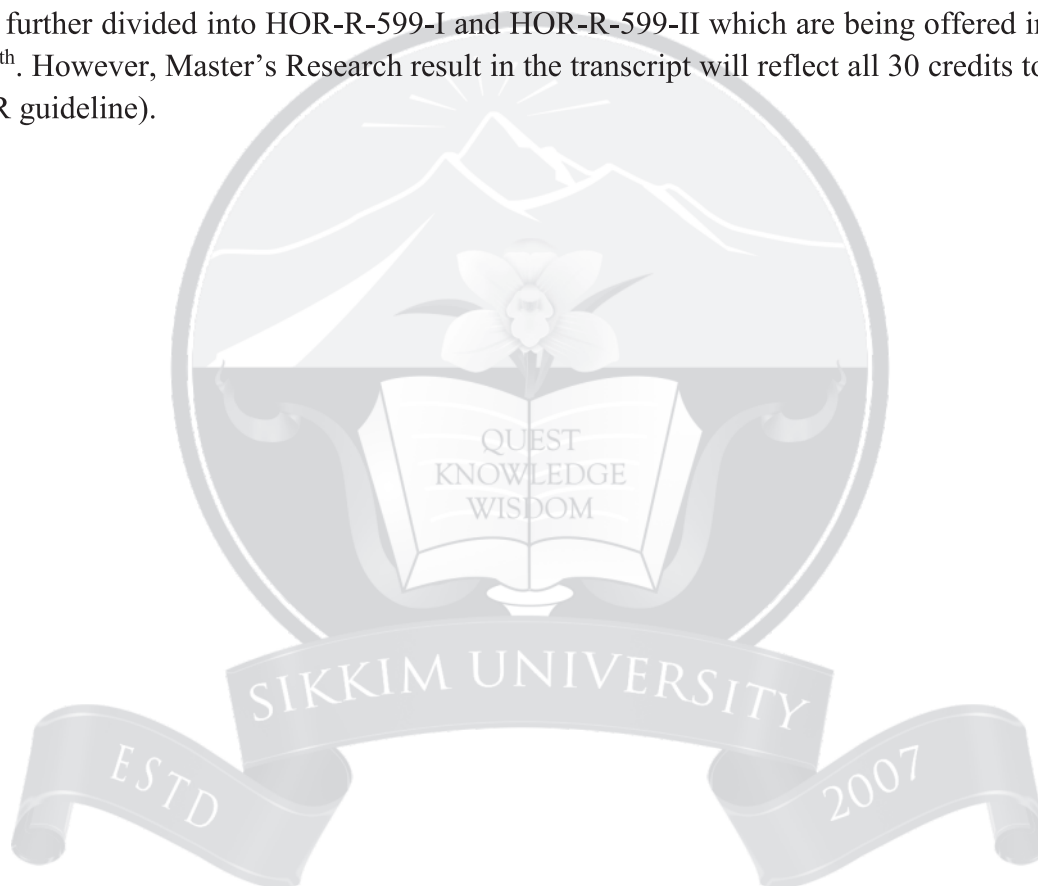
### Suggested Readings:

- Agrios GN. 2005. Plant Pathology. 5<sup>th</sup> Ed. Academic Press, New York
- Baudoin ABAM, Hooper GR, Mathre DE and Carroll RB. 1990. Laboratory Exercises in Plant Pathology: An Instructional Kit. Scientific Publ., Jodhpur.
- Brady NC and Weil RR. 2007. The Nature and Properties of Soils. 14<sup>th</sup> Ed., Prentice
- Chakravarti BP. 2005. Methods of Bacterial Plant Pathology. Agrotech, Udaipur
- Dhingra OD and Sinclair JB. 1986. Basic Plant Pathology Methods. CRC Press, London, Tokyo.
- Forster D and Taylor SC. 1998. Plant Virology Protocols: From Virus Isolation to Transgenic Resistance. Methods in Molecular Biology. Humana Press, Totowa, New Jersey.
- Fox RTV. 1993. Principles of Diagnostic Techniques in Plant Pathology, CABI Wallington.
- Mathews REF. 1993. Diagnosis of Plant Virus Diseases. CRC Press, Boca Raton, Tokyo.
- Noordam D. 1973. Identification of Plant Viruses, Methods and Experiments. Cent. Agric. Pub. Doc. Wageningen.
- Pathak VN. 1984. Laboratory Manual of Plant Pathology. Oxford & IBH, New Delhi.
- Trigiano RN, Windham MT and Windham AS. 2004. Plant Pathology-Concepts and Laboratory Exercises. CRC Press, Florida

### Master's Research

**HOR-C-591 Master's Seminar** offered in 3<sup>rd</sup> semester is a presentation based course where students will do a presentation on the topic related to the Horticulture discipline and the current research trend on that topic. The course will be evaluated by the faculty members of the department on the day of presentation.

**HOR-R-599 Master's Research** is given 30 credits (as per the ICAR guideline) spread over 3<sup>rd</sup> and 4<sup>th</sup> semester. In 3<sup>rd</sup> semester 10 credits of Master's Research are allocated. In 3<sup>rd</sup> semester there will be presentation along with submission of synopsis and review of literature on the topic of research student wants to work. The concern supervisor and the department faculty members will evaluate the performance of the student in 3<sup>rd</sup> semester. For 4<sup>th</sup> semester, Master's Research will be evaluated by the concerned supervisor and external examiner. Just for clarification the Master's Research HOR-R-599 is further divided into HOR-R-599-I and HOR-R-599-II which are being offered in semester 3<sup>rd</sup> and 4<sup>th</sup>. However, Master's Research result in the transcript will reflect all 30 credits together (as per ICAR guideline).



## FRUIT SCIENCE

## SEMESTER-I

Code	Course Title	Type of Course	Credits
HOR-SU-541	Experimental Designs	Supporting	2+0+1
HOR-SU-542	Biotechnology for Crop Improvement	Supporting	2+0+1
HOR-CC-551	Intellectual Property and Its Management in Agriculture	Common	1+0+0
HOR-CC-552	Basic Concepts in Laboratory Techniques	Common	0+0+1
HOR-CC-553	Library and Information Services	Common	0+0+1
HOR-CC-554	Technical Writing and Communications Skills	Common	0+0+1
HOR-CC-555	Agricultural Research, Research Ethics, and Rural Development Programmes	Common	1+0+0
HOR-V-556	Indigenous Traditional Knowledge in Horticulture	Value added	4+0+0
HOR-V-557	Cyber security and privacy	Value added	2+0+0
HOR-S-558	Value addition of Horticultural Crops	Skill Enhancement	1+0+1
HOR-S-559	Diagnosis of disease and identification of insect-pest in Horticulture crops	Skill Enhancement	1+0+1
	Total		21

## SEMESTER-II

Code	Course Title	Type of Course	Credits
HOR-C-501	Tropical Fruit Production	Major/Core	2+0+1
HOR-C-502	Sub-Tropical and Temperate Fruit Production	Major/Core	2+0+1
HOR-C-503	Propagation and Nursery Management of Fruit Crops	Major/Core	2+0+1
HOR-C-504	Breeding of Fruit Crops	Major/Core	2+0+1
	HOR-C-511/521/531	Minor/Elective	2+0+1
	HOR-C-512/522/532	Minor/Elective	2+0+1
	HOR-C-513/523/533	Minor/Elective	2+0+1
	Total		21

## SEMESTER-III

Code	Course Title	Type of Course	Credits
HOR-C-505	Organic Fruit Culture	Major	2+0+1
HOR-C-506	Nutrition of Fruit Crops	Major	2+0+1
HOR-C-507	Minor Fruit Production	Major	2+0+1
HOR-C-591	Master's Seminar	Major	0+0+1
HOR-R-599-I	Master's Research – I	Research	0+0+10
	Total		20

## SEMESTER-IV

Code	Course Title	Type of Course	Credits
HOR-R-599-II	Master's Research – II	Research	0+0+20



**HOR-C-501 TROPICAL FRUIT PRODUCTION****Semester: Second Semester****Total Marks: 100****L+T+P: 2+0+1 = 3****Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course Learning Outcomes**

The students are expected

CLO1: Equip themselves with know-how on agro-techniques for establishment of orchard.

CLO2: Learn production technology of fruit crops

CLO3: Understand the pests and diseases management in fruit crops

CLO4: Learn about the physiological disorders of fruits.

**Theory****Unit I**

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

**Unit II**

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.

**Unit III**

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.

**Unit IV**

**Crops:** Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annona, Aonla, Ber, etc.

**Practical:**

- 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 Teaching Learning Strategies

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

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Bartholomew DP, Paull RE and Rohrbach KG. 2002. The Pineapple: Botany, Production, and Uses. CAB International.
- Bose TK, Mitra SK and Sanyal D. 2002. Fruits of India – Tropical and Sub-Tropical. 3rd Edn. Naya Udyog, Kolkata.
- Dhillon WS. 2013. Fruit Production in India. Narendra Publ. House, New Delhi.
- Iyer CPA and Kurian RM. 2006. High Density Planting in Tropical Fruits: Principles and Practices. IBDC Publishers, New Delhi.
- Litz RE. 2009. The Mango: Botany, Production and Uses. CAB International.
- Madhawa Rao VN. 2013. Banana. ICAR, New Delhi.
- Midmore D. 2015. Principles of Tropical Horticulture. CAB International.
- Mitra SK and Sanyal D. 2013. Guava, ICAR, New Delhi.
- Morton JF. 2013. Fruits of Warm Climates. Echo Point Book Media, USA.

- Nakasome HY and Paull RE. 1998. Tropical Fruits. CAB International.
- Paull RE and Duarte O. 2011. Tropical Fruits (Vol. 1). CAB International.
- Rani S, Sharma A and Wali VK. 2018. Guava (*Psidium guajava* L.). Astral, New Delhi.
- Robinson JC and Saúco VG. 2010. Bananas and Plantains. CAB International.
- Sandhu S and Gill BS. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi.
- Schaffer B, Wolstenholme BN and Whiley AW. 2013. The Avocado: Botany, Production and Uses. CAB International.
- Sharma KK and Singh NP. 2011. Soil and Orchard Management. Daya Publishing House, New Delhi.
- Valavi SG, Peter KV and Thottappilly G. 2011. The Jackfruit. Stadium Press, USA.

### **HOR-C-502 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION**

**Semester: Second Semester**

**Total Marks: 100**

**L+T+P: 2+0+1 = 3**

**Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs**

#### **Course Learning Outcomes**

After successful completion of the course, the students are expected

CLO1: To equip themselves with principles and practices of producing subtropical (citrus, grapes, litchi, pomegranate, etc.) and temperate fruits (apple, pear, peach, plum, apricot, cherries, berries, kiwifruit, etc.) and nuts (almond, walnut, pecan, etc.)

CLO2: Learn production technology of temperate fruit crops

CLO3: Understand the pests and disease management in temperate fruit crops

CLO4: Learn about the physiological disorders of temperate fruits.

#### **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.

##### **Unit II**

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.

### Unit III

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.

### Unit IV

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

### Practical

- 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 Teaching Learning Strategies

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

**Assessment Framework**

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

**Suggested Readings**

- 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

**HOR-C-503      PROPAGATION AND NURSERY MANAGEMENT IN FRUIT CROP**

**Semester: Second Semester**

**Total Marks: 100**

**L+T+P: 2+0+1 = 3**

**Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs**

**Course Learning Outcomes**

The student would be expected to

CLO1: Equip to acquire skills and knowledge on principles and practices of macro and micropropagation

CLO2: Handling of propagated material in nursery.

**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**

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

**Unit III**

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 IV**

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, 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 – meristem tip culture, axillary bud culture, micro-grafting, hardening;
- Visit to commercial tissue culture laboratories and accredited nurseries.

## Suggested Teaching Learning Strategies

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

## Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO



### Suggested Readings

- Bose TK, Mitra SK and Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkatta.
- Davies FT, Geneve RL and Wilson SB. 2018. Hartmann and Kester's Plant Propagation- Principles and Practices. Pearson, USA/ Prentice Hall 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.

**HOR-C-504 BREEDING OF FRUIT CROPS****Semester: Second Semester****Total Marks: 100****L+T+P: 2+0+1 = 3****Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course Learning Outcomes**

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

CLO1: Have an understanding on importance and peculiarities of fruit breeding

CLO2: Have an updated knowledge on reproductive biology, genetics and inherent breeding systems.

CLO3: Have detailed knowledge of various methods/ approaches of breeding fruit crops

**Theory****Unit I**

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

**Unit II**

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

**Unit III**

Conventional and Non-Conventional Breeding: Approaches for crop improvement – direct introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrusts.

**Unit IV**

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

**Practical**

- Exercises on bearing habit, floral biology;
- Pollen viability and fertility studies;
- Hands on practices in hybridization;
- Raising and handling of hybrid progenies;
- Induction of mutations and polyploidy;

- Evaluation of biometrical traits and quality traits;
- Screening for resistance against abiotic stresses;
- Developing breeding programme for specific traits;
- Visit to research stations working on fruit breeding.

### Suggested Teaching Learning Strategies

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

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- 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.

## **HOR-C-505 ORGANIC FRUIT CULTURE**

**Semester: Third Semester**

**Total Marks: 100**

**L+T+P: 2+0+1 = 3**

**Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs**

### **Course Learning Outcomes**

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

CLO1: Familiarize with the concepts and practices of organic and other natural farming systems

CLO2: Generate know-how on procedures, policies and regulation for inspection and certification of organic produce

### **Theory**

#### **Unit I**

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

#### **Unit II**

Farming System and Practices: Organic farming systems including biodynamic farming, natural farming, homa organic farming, rishi krishi, EM technology, cosmic farming; on-farm and off-farm production of organic inputs, role of bio-fertilizers, bio enhancers, legumes, inter cropping, cover crops, green manuring, zero tillage, mulching and their role in organic nutrition management. Organic seeds and planting materials, soil health management in organic production, weed management practices in organic farming, biological management of pests and diseases, trap crops, quality improvement in organic production of fruit crops.

#### **Unit III**

Inspection, Control Measures, and Certification: Inspection and certification of organic produce, participatory guarantee system (PGS), NPOP, documentation and control, development of internal control system (ICS), Concept of group certification, constitution of grower group as per NPOP, preparation of ICS manual, internal and external inspection, concept of third party verification, certification of small farmer groups (Group Certification), transaction certificate, group certificate, critical control points (CCP) and HACCP, IFOAM guidelines on certification scope and chain of

custody, certification trademark – The Logo, accredited certification bodies under NPOP. Constraints in certification, IFOAM and global scenario of organic movement, postharvest management of organic produce. Economics of organic fruit production.

### Practical

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

### Suggested Teaching Learning Strategies

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

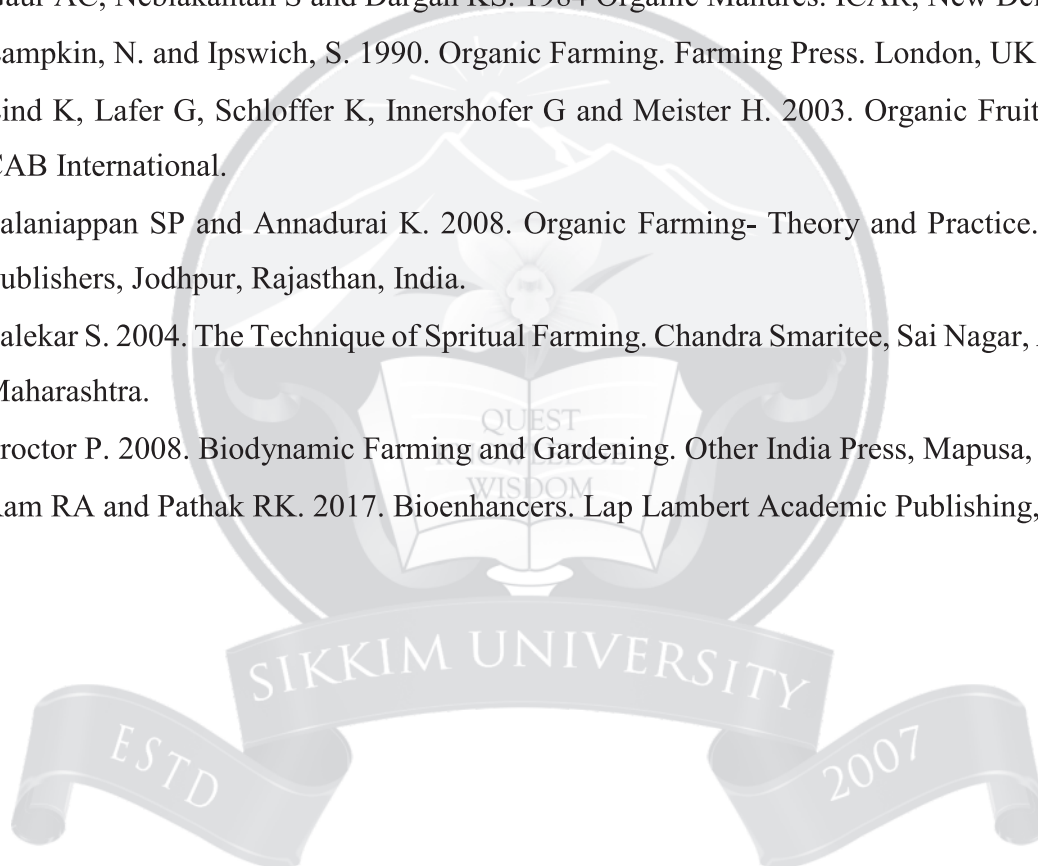
### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Claude A. 2004. The Organic Farming Sourcebook. Other India Press, Mapusa, Goa, India.
- Dabholkar SA. 2001. Plenty for All. Mehta Publishing House, Pune, Maharashtra.
- Das HC and Yadav AK. 2018. Advances in Organic Production of Fruit Crops. Westville Publishing House, New Delhi.
- Deshpande MS. 2003. Organic Farming with respect to Cosmic Farming. Mrs. Pushpa Mohan Deshpandey, Kolhapur, Maharashtra.
- Deshpande WR. 2009. Basics of Organic Farming. All India Biodynamic and Organic Farming Association, Indore. MP.
- Gaur AC, Neblakantan S and Dargan KS. 1984 Organic Manures. ICAR, New Delhi.
- Lampkin, N. and Ipswich, S. 1990. Organic Farming. Farming Press. London, UK.
- Lind K, Lafer G, Schloffer K, Innershofer G and Meister H. 2003. Organic Fruit Growing. CAB International.
- Palaniappan SP and Annadurai K. 2008. Organic Farming- Theory and Practice. Scientific Publishers, Jodhpur, Rajasthan, India.
- Palekar S. 2004. The Technique of Spritual Farming. Chandra Smaritee, Sai Nagar, Amrawati, Maharashtra.
- Proctor P. 2008. Biodynamic Farming and Gardening. Other India Press, Mapusa, Goa.
- Ram RA and Pathak RK. 2017. Bioenhancers. Lap Lambert Academic Publishing, AP.





**HOR-C-506 NUTRITION OF FRUIT CROPS****Semester: Third Semester****Total Marks: 100****L+T+P: 2+0+1 = 3****Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course Learning Outcomes**

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

CLO1: Know the importance and various types of nutrients and their uptake mechanisms

CLO2: Analyse soil and plant status with respect to various nutrients

CLO3: Make use of corrective measures to overcome deficiency or toxicity

**Theory****Unit I**

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

**Unit II**

Estimation and Application: Nutrient requirements, root distribution in fruit crops, soil and foliar application of nutrients in major fruit crops, fertilizer use efficiency. Methods and techniques for evaluating the requirement of macro- and micro-elements,

**Unit III**

Diagnosis: Diagnostic and interpretation techniques including DRIS. Role of different macro and micro-nutrients, their deficiency and toxicity disorders, corrective measures to overcome deficiency and toxicity disorders.

**Unit IV**

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

**Practical**

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



## SUGGESTED TEACHING LEARNING STRATEGIES

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

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

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

- Yawalkar KS, Agarwal JP and Bokde S. 1972. Manures and Fertilizers. 3rd Ed. Agri Horticultural Publishing House, Nagpur.

### **HOR-C-507 MINOR FRUIT PRODUCTION**

**Semester: Third Semester**

**Total Marks: 100**

**L+T+P: 2+0+1 = 3**

**Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs**

#### **Course Learning Outcomes**

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

CLO1: Various minor fruits hitherto neglected and their commercial value

CLO2: Efforts made to domesticate minor fruits and standardization of agro-techniques.

CLO3: Their utilization in processing industry.

#### **Theory**

##### **Unit I**

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

##### **Unit II**

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

##### **Unit III**

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

##### **Unit IV**

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

#### **Practical**

- Visits to institutes located in the hot and cold arid regions of the country;
- Identification of minor fruit plants/ cultivars;

- Collection of leaves and preparation of herbarium;
- Allelopathic studies;
- Generating know-how on the reproductive biology of minor fruits;
- Fruit quality attributes and biochemical analysis;
- Project formulation for establishing commercial orchards in fragile ecosystems.

### Suggested Teaching Learning Strategies

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

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Ghosh SN, Singh A and Thakur A. 2017. Underutilized Fruit Crops: Importance and Cultivation. Jaya Publication House, New Delhi.
- Krishna H and Sharma RR, 2017. Fruit Production: Minor Fruits. Daya Publishing House, New Delhi.
- Mazumdar BC. 2014. Minor Fruit Crops of India: Tropical and Subtropical. Daya Publication House, New Delhi.
- Nath V, Kumar D, Pandey V and Pandey D. 2008. Fruits for the Future. Satish Serial Publishing House, New Delhi.
- Pareek OP, Sharma S, and Arora RK. 2007. Underutilised Edible Fruits and Nuts, IPGRI, Rome.
- Peter KV. 2010. Underutilized and Underexploited Horticultural Crops. NIPA, New Delhi.

- Rana JC and Verma VD. 2011. Genetic Resources of Temperate Minor Fruit (Indigenous and Exotic). NBPGR, New Delhi.
- Saroj PL and Awasthi OP. 2005. Advances in Arid Horticulture, Vol. II: Production Technology of Arid and Semiarid Fruits. IBDC, Lucknow.
- Saroj PL, Dhandar DG and Vashishta BB. 2004. Advances in Arid Horticulture, Vol.-1 Present Status. IBDC, Lucknow.
- Singh et al. 2011. Jamun. ICAR, New Delhi.

## VEGETABLE SCIENCE

### SEMESTER-I

Code	Course Title	Type of Course	Credits
HOR-SU-541	Experimental Designs	Supporting	2+0+1
HOR-SU-542	Biotechnology for Crop Improvement	Supporting	2+0+1
HOR-CC-551	Intellectual Property and Its Management in Agriculture	Common	1+0+0
HOR-CC-552	Basic Concepts in Laboratory Techniques	Common	0+0+1
HOR-CC-553	Library and Information Services	Common	0+0+1
HOR-CC-554	Technical Writing and Communications Skills	Common	0+0+1
HOR-CC-555	Agricultural Research, Research Ethics, and Rural Development Programmes	Common	1+0+0
HOR-V-556	Indigenous Traditional Knowledge in Horticulture	Value added	4+0+0
HOR-V-557	Cyber security and privacy	Value added	2+0+0
HOR-S-558	Value addition of Horticultural Crops	Skill Enhancement	1+0+1
HOR-S-559	Diagnosis of disease and identification of insect-pest in Horticulture crops	Skill Enhancement	1+0+1
	Total		21

### SEMESTER-II

Code	Course Title	Type of Course	Credits
HOR-C-511	Production of Cool Season Vegetable Crops	Major	2+0+1
HOR-C-512	Production Technology of Warm Season Vegetable Crops	Major	2+0+1
HOR-C-513	Growth and Development of Vegetable Crops	Major	2+0+1
HOR-C-514	Principles of Vegetable Breeding	Major	2+0+1
	HOR-C-501/521/531	Minor	2+0+1
	HOR-C-502/522/532	Minor	2+0+1
	HOR-C-503/523/533	Minor	2+0+1
	Total		21

**SEMESTER-III**

Code	Course Title	Type of Course	Credits
HOR-C-515	Breeding of Self-pollinated Vegetable Crops	Major	2+0+1
HOR-C-516	Breeding of Cross-pollinated Vegetable Crops	Major	2+0+1
HOR-C-517	Seed production of Vegetable Crops	Major	2+0+1
HOR-C-591	Master's Seminar	Major	0+0+1
HOR-R-599-I	Master's Research- I	Research	0+0+10
	Total		20

**SEMESTER-IV**

Code	Course Title	Type of Course	Credits
HOR-R-599-II	Master's Research- II	Research	0+0+20

**HOR-C-511 PRODUCTION OF COOL SEASON VEGETABLE CROPS****Semester: Second Semester****Total Marks: 100****L+T+P: 2+0+1 = 3****Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course Learning Outcomes:**

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

CLO1: Appreciate the scope and scenario of cool season vegetable crops in India

CLO2: Acquire knowledge about the production technology and post-harvest handling of cool season vegetable crops

CLO3: Calculate the economics of vegetable production in India

**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 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.

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 Teaching Learning Strategies

- Classroom lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion



## Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

## Suggested Readings

- 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 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.

## HOR-C-512 PRODUCTION OF WARM SEASON VEGETABLE CROPS

**Semester: Second Semester**

**Total Marks: 100**

**L+T+P: 2+0+1 = 3**

**Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs**

### Course Learning Outcomes

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

CLO1: Appreciate the scope and scenario of warm season vegetable crops in India

CLO2: Acquire knowledge about the production technology and post-harvest handling of warm season vegetable crops

CLO3: Calculate the economics of vegetable production in India

### 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 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.

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 Teaching Learning Strategies

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

**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. Handbook 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 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.

**HOR-C-513 GROWTH AND DEVELOPMENT OF VEGETABLE CROPS****Semester: Second Semester****Total Marks: 100****L+T+P: 2+0+1 = 3****Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course Learning Outcomes**

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

CLO1: Acquire knowledge about the growth and development of plants in vegetable crops

CLO2: Distinguish between primary and secondary growth in plant stems

CLO3: Understand how hormones affect the growth and development of vegetable crops

**Theory****Unit I**

Introduction and phytohormones—Definition of growth and development; Cellular structures and their functions; Physiology of phytohormones functioning/ biosynthesis and mode of action; Growth analysis and its importance in vegetable production.

**Unit II**

Physiology of dormancy and germination—Physiology of dormancy and germination of vegetable seeds, tubers, and bulbs; Role of auxins, gibberellins, cytokinin, and abscisic acid; Application of synthetic PGRs including plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactin, anti-transpirant, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

**Unit III**

Abiotic factors—Impact of light, temperature, photoperiod, carbon dioxide, oxygen, and other gases on growth, development of underground parts, flowering, and sex expression in vegetable crops; Apical dominance.

**Unit IV**

Fruit physiology—Physiology of fruit set, fruit development, fruit growth, flower, and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence, and abscission; fruit ripening and physiological changes associated with ripening.

Morphogenesis and tissue culture—Morphogenesis and tissue culture techniques in vegetable crops; Grafting techniques in different vegetable crops.

**Practical**

- Preparation of plant growth regulator's solutions and their application;



- Experiments in breaking and induction of dormancy by chemicals;
- Induction of parthenocarpy and fruit ripening;
- Application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables;
- Growth analysis techniques in vegetable crops;
- Grafting techniques in tomato, brinjal, cucumber and sweet pepper.

### SUGGESTED TEACHING LEARNING STRATEGIES

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedure
- Group discussion

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Reading

- Bleasdale JKA. 1984. Plant physiology in relation to horticulture (2nd Edition) MacMillan.
- Gupta US. Eds. 1978. Crop physiology. Oxford and IBH, New Delhi.
- Kalloo G. 2017. Vegetable grafting: Principles and practices. CAB International
- Krishnamoorti HN. 1981. Application growth substances and their uses in agriculture. Tata McGraw Hill, New Delhi.
- Leopold AC and Kriedemann PE. 1981. Plant growth and development, Tata McGraw-Hill, New Delhi.
- Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.



- Peter KV. (Eds). 2008. Basics of horticulture. New India publication agency, New Delhi.
- Rana MK. 2011. Physio-biochemistry and Biotechnology of Vegetables. New India Publishing Agency, Pritam Pura, New Delhi.
- Saini et al. (Eds.). 2001. Laboratory manual of analytical techniques in horticulture. Agrobios, Jodhpur.
- Wien HC. (Eds.). 1997. The physiology of vegetable crops. CAB International.

### **HOR-C-514 PRINCIPLES OF VEGETABLE BREEDING**

**Semester: Second Semester**

**Total Marks: 100**

**L+T+P: 2+0+1 = 3**

**Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs**

#### **Course Learning Outcomes**

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

CLO1: Acquire knowledge about the principles of vegetable breeding

CLO2: Improve yield, quality, abiotic and biotic resistance, other important traits of vegetable crops

CLO3: Understand how the basic principles are important to start breeding of vegetable crops

#### **Theory**

##### **Unit I**

*Importance and history-* Importance, history and evolutionary aspects of vegetable 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 vegetable crops and vegetables suitable for protected environment.

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

### Practical

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

### Suggested Teaching Learning Strategies

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- 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.
- Kole CR. 2007. Genome mapping and molecular breeding in plants-vegetables. Springer, USA.
- Peter KV and 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.

### **HOR-C-515 BREEDING OF SELF-POLLINATED VEGETABLE CROPS**

**Semester: Third Semester**

**Total Marks: 100**

**L+T+P: 2+0+1 = 3**

**Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs**

#### **Course Learning Outcomes**

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

CLO1: Acquire knowledge about the breeding of self-pollinated vegetable crops

CLO2: Improve yield, quality, abiotic and biotic resistance, and other important traits of vegetable crops

CLO3: Understand how to start the breeding of self-pollinated vegetable crops

#### **Theory**

Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination and fertilization mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, breeding for protected environment and quality improvement, molecular markers and marker's assisted breeding; QTLs, PPV and FR Act.

#### **Unit I**

*Tuber crops:* Potato.

*Leafy vegetables-* Lettuce and fenugreek.

#### **Unit II**

*Fruit vegetables-* Tomato, eggplant, hot pepper, sweet pepper and okra.

#### **Unit III**

*Leguminous vegetables-* Garden peas and cowpea.

#### **Unit IV**

*Leguminous vegetables:* French bean, Indian bean, cluster bean and broad bean.

## Practical

- Floral mechanisms favouring self and often cross pollination;
- Progeny testing and development of inbred lines;
- Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations;
- Palynological studies, selfing and crossing techniques;
- Hybrid seed production of vegetable crops in bulk;
- Screening techniques for biotic and abiotic stress resistance in above mentioned crops;
- Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques;
- Visit to breeding farms

## Suggested Teaching Learning Strategies

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

## Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

## Suggested Readings

- Allard RW. 1999. Principles of plant breeding. John Wiley and Sons.
- Basset MJ. (Ed.). 1986. Breeding vegetable crops. AVI Publ.
- Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005, Plant genetic resources: horticultural crops. Narosa Publ. House.

- Fageria MS, Arya PS and Choudhary AK. 2000, Vegetable crops: Breeding and seed production. Vol. I. Kalyani.
- Gardner EJ. 1975. Principles of genetics. John Wiley and Sons.
- Hayes HK, Immer FR and Smith DC. 1955. Methods of plant breeding. McGraw-Hill.
- Hayward MD, Bosemark NO and Romagosa I. (Eds.). 1993. Plant Breeding-principles and prospects. Chapman and Hall.
- Hazra P and Som MG. 2015. Vegetable Science (Second revised edition), Kalyani publishers, Ludhiana, 598 p.
- Hazra P and Som MG. 2016. Vegetable seed production and hybrid technology (Second revised edition), Kalyani Publishers, Ludhiana, 459 p
- Kalloo G. 1988. Vegetable breeding. Vols. I-III. CRC Press.
- Kalloo G. 1998. Vegetable breeding. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
- Kumar JC and Dhaliwal MS. 1990. Techniques of developing hybrids in vegetable crops. Agro Botanical Publ.
- Paroda RS and Kalloo G. (Eds.). 1995. Vegetable research with special reference to hybrid technology in Asia-Pacific Region. FAO.
- Peter KV and Pradeepkumar T. 2008. Genetics and breeding of vegetables. Revised, ICAR.
- Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
- Peter KV and Hazra P (Eds). 2015. Hand book of vegetables Volume II. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509 p.
- Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume III. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634 p.
- Rai N and Rai M. 2006. Heterosis breeding in vegetable crops. New India Publ. Agency.
- Ram HH. 1998. Vegetable breeding: principles and practices. Kalyani Publishers, New Delhi.
- Simmonds NW. 1978. Principles of crop improvement. Longman. Singh BD. 1983. Plant Breeding. Kalyani Publishers, New Delhi.
- Singh PK, Dasgupta SK and Tripathi SK. 2004. Hybrid vegetable development. International Book Distributing Co.

**HOR-C-516 BREEDING OF CROSS POLLINATED VEGETABLE CROPS (2+1)****Semester: Third Semester****Total Marks: 100****L+T+P: 2+0+1 = 3****Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course Learning Outcomes**

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

CLO1: Acquire knowledge about the breeding of cross pollinated vegetable crops

CLO2: Improve yield, quality, abiotic and biotic resistance, and important traits of cross pollinated vegetable crops

CLO3: Understand how to start the breeding of cross pollinated vegetable crops

**Theory**

Origin, botany, taxonomy, cytogenetics, genetics, types of pollination and fertilization, mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation, polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding, and QTLs, PPV and FR act

**Unit I:**

*Cucurbitaceous crops*—Gourds, melons, cucumber, pumpkin and squashes.

**Unit II**

*Cole crops*—Cauliflower, cabbage, kohlrabi, broccoli and brussels sprouts.

**Unit III**

*Root and bulb crops*—Carrot, radish, turnip, beet root and onion.

**Unit IV:**

*Tuber crops*—Sweet potato, tapioca, taro and yam.

*Leafy vegetables*—Beet leaf, spinach, amaranth and coriander.

**Practical**

- Floral mechanisms favouring cross pollination;
- Development of inbred lines;
- Selection of desirable plants from breeding population;
- Observations and analysis of various quantitative and qualitative traits in germplasm, hybrids and segregating generations;



- Induction of flowering, palynological studies, selfing and crossing techniques;
- Hybrid seed production of vegetable crops in bulk; Screening techniques for biotic and abiotic stress resistance in above mentioned crops;
- Demonstration of sib-mating and mixed population;
- Molecular marker techniques to identify useful traits in vegetable crops and special breeding techniques;
- Visit to breeding blocks.

### Suggested Teaching Learning Strategies

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation individual or in group
- Hands on training of different procedures
- Group discussion

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Allard RW. 1999. Principles of plant breeding. John Wiley and Sons.
- Basset MJ. (Ed.). 1986. Breeding vegetable crops. AVI Publ.
- Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. Plant genetic resources: horticultural crops. Narosa publ. house.
- Fageria MS, Arya PS and Choudhary AK. 2000. Vegetable crops: breeding and seed production. Vol. I. Kalyani.
- Gardner EJ. 1975. Principles of genetics. John Wiley and Sons.
- Hayes HK, Immer FR and Smith DC. 1955. Methods of plant breeding. McGraw-Hill.
- Hayward MD, Bosemark NO and Romagosa I. (Eds.), 1993. Plant breeding-principles and prospects. Chapman and Hall.

- Hazra P and Som MG. 2015. Vegetable science (Second revised edition), Kalyani publishers, Ludhiana, 598 p.
- Hazra P and Som MG. 2016. Vegetable seed production and hybrid technology (Second revised edition), Kalyani Publishers, Ludhiana, 459 p
- Kalloo G. 1988. Vegetable breeding. Vols. I-III. CRC Press.
- Kalloo G. 1998. Vegetable breeding. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
- Kumar JC and Dhaliwal MS. 1990. Techniques of developing hybrids in vegetable crops. Agro botanical publ.
- Paroda RS and Kalloo G. (Eds.). 1995. Vegetable research with special reference to hybrid technology in Asia-Pacific region. FAO.
- Peter KV and Pradeepkumar T. 2008. Genetics and breeding of vegetables. revised, ICAR.
- Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
- Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume II and III. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509 p.
- Prohens J and Nuez F. 2007. Handbook of Plant Breeding- Vegetables (Vol I and II), Springer, USA.
- Rai N and Rai M. 2006. Heterosis breeding in vegetable crops. New India Publ. Agency.
- Ram HH. 1998. Vegetable breeding: principles and practices. Kalyani Publishers, New Delhi.
- Simmonds NW. 1978. Principles of crop improvement. Longman.
- Singh BD. 1983. Plant breeding. Kalyani Publishers, New Delhi.
- Singh PK, Dasgupta SK and Tripathi SK. 2004. Hybrid vegetable development. International book distributing Co.
- Swarup V. 1976. Breeding procedure for cross-pollinated vegetable crops. ICAR.

**HOR-C-517 SEED PRODUCTION OF VEGETABLE CROPS****Semester: Third Semester Course Level: 500****Total Marks: 100****L+T+P: 2+0+1 = 3****Credits Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 30 Hrs****Course Learning Outcomes**

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

CLO1: Appreciate the scope and scenario of seed production of vegetable crops in India

CLO2: Acquire knowledge about the complete seed production technology, extraction and post-extraction processing of vegetable seeds

CLO3: Adoption of seed production of vegetable crops as entrepreneur

**Theory****Unit I**

Introduction, history, propagation and reproduction—Introduction, definition of seed and its quality, seed morphology, development and maturation; Apomixis and fertilization; Modes of propagation and reproductive behaviour; Pollination mechanisms and sex forms in vegetables; History of vegetable seed production; Status and share of vegetable seeds in seed industry

**Unit II**

Agro-climate and methods of seed production—Agro-climate and its influence on quality seed production; Deterioration of crop varieties, genetical and agronomic principles of vegetable seed production; Methods of seed production, hybrid seeds and techniques of large scale hybrid seed production; Seed village concept

**Unit III**

Seed multiplication and its quality maintenance—Seed multiplication ratios and replacement rates in vegetables; Generation system of seed multiplication; Maintenance and production of nucleus, breeder, foundation, certified/ truthful label seeds; Seed quality and mechanisms of genetic purity testing

Seed harvesting, extraction and its processing—Maturity standards; Seed harvesting, curing and extraction; Seed processing, viz., cleaning, drying and treatment of seeds, seed health and quality enhancement, packaging and marketing; Principles of seed storage; Orthodox and recalcitrant seeds; Seed dormancy

**Unit IV**

Improved agro-techniques and field and seed standards—Improved agro-techniques; Field and seed standards in important solanaceous, leguminous and cucurbitaceous vegetables, cole crops, leafy

vegetables, bulbous and root crops and okra; clonal propagation and multiplication in vegetative propagated crops; Seed plot technique and true potato seed production in potato

### Practical

- Study of floral biology and pollination mechanisms in vegetables;
- Determination of modes of pollination;
- Field and seed standards;
- Use of pollination control mechanisms in hybrid seed production of important vegetables;
- Maturity standards and seed extraction methods;
- Seed sampling and testing;
- Visit to commercial seed production areas;
- Visit to seed processing plant;
- Visit to seed testing laboratories.

### SUGGESTED TEACHING LEARNING STRATEGIES

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Agarwaal PK and Anuradha V. 2018. Fundamentals of seed science and technology. Brilliant publications, New Delhi.

- Agrawal PK and Dadlani M. (Eds.). 1992. Techniques in seed science and technology. South asian Publ.
- Agrawal RL. (Ed.). 1997. Seed technology. Oxford and IBH.
- Basra AS. 2000. Hybrid seed production in vegetables. CRC press, Florida, USA.
- Bench ALR and Sanchez RA. 2004. Handbook of seed physiology. Food products press, NY/ London.
- Bendell PE. (Eds.). 1998. Seed science and technology: Indian forestry species. Allied Publ.
- Chakraborty SK, Prakash S, Sharma SP and Dadlani M. 2002. Testing of distinctiveness, uniformity and stability for plant variety protection. IARI, New Delhi
- Copland LO and McDonald MB. 2004. Seed science and technology, Kluwer Academic Press.
- Fageria MS, Arya PS and Choudhary AK. 2000. Vegetable crops: breeding and seed production. Vol. I. Kalyani Publishers, New Delhi.
- George RAT. 1999. Vegetable seed production (2nd Edition). CAB International.
- Kalloo G, Jain SK, Vari AK and Srivastava U. 2006. Seed: A global perspective. Associated publishing company, New Delhi.
- Hazra P and Som HG. 2015. Seed production and hybrid technology of vegetable crops. Kalyani publishers, Ludhiana.
- Kumar JC and Dhaliwal MS. 1990. Techniques of developing hybrids in vegetable crops. Agro botanical publ.
- More TA, Kale PB and Khule BW. 1996. Vegetable seed production technology. Maharashtra state seed corp.
- Rajan S and Markose BL. 2007. Propagation of horticultural crops. New India publ. agency.
- Singh NP, Singh DK, Singh YK and Kumar V. 2006. Vegetable seed production technology. International book distributing Co.
- Singh SP. 2001. Seed production of commercial vegetables. Agrotech publ. academy.
- Singhal NC. 2003. Hybrid seed production. Kalyani publishers, New Delhi



**FLORICULTURE AND LANDSCAPING****SEMESTER-I**

<b>Code</b>	<b>Course Title</b>	<b>Type of Course</b>	<b>Credits</b>
HOR-SU-541	Experimental Designs	Supporting	2+0+1
HOR-SU-542	Biotechnology for Crop Improvement	Supporting	2+0+1
HOR-CC-551	Intellectual Property and Its Management in Agriculture	Common	1+0+0
HOR-CC-552	Basic Concepts in Laboratory Techniques	Common	0+0+1
HOR-CC-553	Library and Information Services	Common	0+0+1
HOR-CC-554	Technical Writing and Communications Skills	Common	0+0+1
HOR-CC-555	Agricultural Research, Research Ethics, and Rural Development Programmes	Common	1+0+0
HOR-V-556	Indigenous Traditional Knowledge in Horticulture	Value added	4+0+0
HOR-V-557	Cyber security and privacy	Value added	2+0+0
HOR-S-558	Value addition of Horticultural Crops	Skill Enhancement	1+0+1
HOR-S-559	Diagnosis of disease and identification of insect-pest in Horticulture crops	Skill Enhancement	1+0+1
	Total		21

**SEMESTER-II**

<b>Code</b>	<b>Course Title</b>	<b>Type of Course</b>	<b>Credits</b>
HOR-C-521	Systematics of Ornamental Plants	Major	2+0+1
HOR-C-522	Commercial Production of Cut Flowers	Major	2+0+1
HOR-C-523	Commercial Production of Loose Flowers	Major	2+0+1
HOR-C-524	Breeding of Ornamental Plants	Major	2+0+1
	HOR-C-501/511/531	Minor	2+0+1
	HOR-C-502/512/532	Minor	2+0+1
	HOR-C-503/513/533	Minor	2+0+1
	Total		21

**SEMESTER-III**

<b>Code</b>	<b>Course Title</b>	<b>Type of Course</b>	<b>Credits</b>
HOR-C-525	Ornamental Gardening and Landscaping	Major	2+0+1
HOR-C-526	Turf Grass Management	Major	2+0+1
HOR-C-527	CAD for Landscaping	Major	2+0+1
HOR-C-591	Master's Seminar	Major	0+0+1
HOR-R-599-I	Master's Research – I	Research	0+0+10
	Total		20

**SEMESTER-IV**

<b>Code</b>	<b>Course Title</b>	<b>Type of Course</b>	<b>Credits</b>
HOR-R-599-II	Master's Research – II	Research	0+0+20



**HOR-C-521 SYSTEMATICS OF ORNAMENTAL PLANTS****Semester: Second semester****Total Marks: 100****L+T+P: 2+0+1= 3 Credits****Lecture: 30 Hrs + Tutorial: 0 Hrs+ Practical: 30 Hrs****COURSE LEARNING OUTCOMES**

CLO1: The students will have an in-depth knowledge of nomenclature, description of important genera, and use of molecular techniques in the systematics of flower crops.

**Theory****Unit I**

Nomenclature: History, origin, hotspots, classification, and nomenclature systems. International systems: International Code, Treaties, International, and National Organisations,

**Unit II**

Biodiversity Act, Identification features, Descriptors. Red Book, Registration (NBPGR, PPVFRA, NBA).

**Unit III**

Families: Description of families and important genera of: Rosaceae, Asteraceae, Caryophyllaceae, Orchidaceae, Aracaceae, Liliaceae.

**Unit IV**

Acanthaceae, Palmaceae, Asparagaceae, Malvaceae, Musaceae, Oleaceae, Iridaceae.

**Practical**

- Different nomenclature systems of plants;
- Floral biology and taxonomic description of Rose, chrysanthemum, Orchids, Carnation, Gerbera, Anthurium, Marigold, Tuberose, Jasmine, China Aster, Lilium, Gypsophila;
- Cryopreservation and tissue culture repository;
- Molecular techniques.

**SUGGESTED TEACHING LEARNING STRATEGIES**

- Lectures
- Group discussions
- Flip classes
- Assignment and student presentation
- Hands on training of different procedures

**Assessment Framework**

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

**Suggested Readings**

- Bhattacharya B and Johri BM. 2004. Flowering Plants: Taxonomy and Phylogeny. Narosa Publ. House, New Delhi, India. pp.753.
- Dutta AC. 1986. A Class Book of Botany. Oxford Univ. Press, Kolkata, India.
- Pandey BP. 2013. Taxonomy of Angiosperms. S. Chand & Co. pp. 608.
- Rajput CBS and Haribabu RS. 2014. Citriculture, Kalyani Publishers, New Delhi, India.
- Spencer RR, Cross R and Lumley P. 2007. Plant Names. 3rd Ed. A Guide to Botanical Nomenclature. CSIRO Publ., Australia., 176 p.
- Vasistha BB. 1998. Taxonomy of Angiosperms. Kalyani Publishers, New Delhi, India.

**HOR-C-522 COMMERCIAL PRODUCTION OF CUT FLOWERS****Semester: Second Semester****Total Marks: 100****L+T+P: 2+0+1= 3 Credits****Lecture: 30 Hrs + Tutorial: 0 Hrs+ Practical: 30 Hrs****Course Learning Outcomes**

CLO1: Understand the scope and scenario of floriculture.

CLO2: A thorough understanding of production and postharvest management of flower crops.

CLO3: Acquire the required skills to prepare project reports on different crops for financing.

**Theory****Unit I**

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

**Unit II**

Growing environment: Soil 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.

**Unit III**

Crop management: Commercial Flower production – Commercial varieties, water and nutrient management, fertigation, weed management, crop specific practices, ratooning, training and pruning, pinching, de-shooting, bending, de-suckering, 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.

**Unit IV**

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.

**Crops:** Rose, chrysanthemum, gladiolus, tuberose, carnation, gerbera, orchids, liliun, anthurium, china aster, alstroemeria, bird of paradise, heliconia, alpinia, ornamental ginger, dahlia, gypsophila, solidago, limonium, stock, cut greens and fillers.

### Practical

- Identification of varieties;
- Propagation;
- Microclimate management;
- Training and pruning techniques;
- Pinching, d-eshooting, dis-budding, de-suckering;
- Practices in manuring, drip and fertigation, foliar nutrition, and 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 units;
- Case studies.

### Suggested Teaching Learning Strategies

- Lectures
- Group discussions
- Flip classes
- Assignment and student presentation
- Hands on training of different procedures
- Exposure visits

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

**Suggested Readings**

- 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.
- Reddy S, Janakiram T, Balaji Kulkarni S and Misra RL. 2007. Hi- Tech Floriculture. Indian Society of Ornamental Horticulture, New Delhi, India.
- Singh AK. 2006. Flower Crops: Cultivation and Management. New India Publ. Agency, New Delhi, India. pp. 475.

**HOR-C-523 COMMERCIAL PRODUCTION OF LOOSE FLOWER****Semester: Second semester****Total Marks: 100****L+T+P: 2+0+1= 3 Credits****Lecture: 30 Hrs + Tutorial: 0 Hrs+ Practical: 30 Hrs****Course Learning Outcomes**

CLO1: A thorough understanding of production and post-harvest management of loose flowers.

CLO2: Develop the required skills in commercial production management

**Theory****Unit I**

Scope and scenario: Scope, scenario, importance, constraints, and opportunities in loose flower production.

**Unit II**

Growing environment: Nursery management, pro-tray nursery under shade nets, soil, and climate requirement, Field preparation, systems of planting.

**Unit III**

Crop management: Soil analysis, soil health card, water, and nutrient management, weed management, training and pruning, special horticultural practices such as pinching and dis-budding, use of growth regulators, physiological disorders and remedies, INM, IPM, and IDM. Crop regulation: Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation.

**Unit IV**

Post-harvest management: Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packaging, and storage. Marketing: Important local markets, Export potential, transportation and marketing, APMC, and online trading, institutional support, Crop Insurance.

**Crops:** Rose, jasmine, chrysanthemum, marigold, tuberose, china aster, crossandra, gaillardia, spider lily, hibiscus, nerium, barleria, celosia, gomphrena, Madar (*Calotropis gigantea*), nyctanthes



(Harsingar), tabernaemontana (Chandni), lotus water lily, michelia (Champa), gardenia, ixora and balsam.

### Practical

- Identification of species and varieties;
- Propagation and nursery management;
- Training and pruning techniques;
- Fertigation, foliar nutrition, growth regulator application;
- Crop protection;
- Pinching, disbudding, staking, harvesting techniques;
- Post-harvest handling, storage and cold chain;
- Project preparation for regionally important commercial loose flowers. crop specific guidelines for project financing (NHB guidelines);
- Cost Economics;
- Exposure Visits to fields.

### Suggested Teaching Learning Strategies

- Lectures
- Group discussions
- Flip classes
- Assignment and group seminars
- Hands on training of different techniques
- Exposure visits

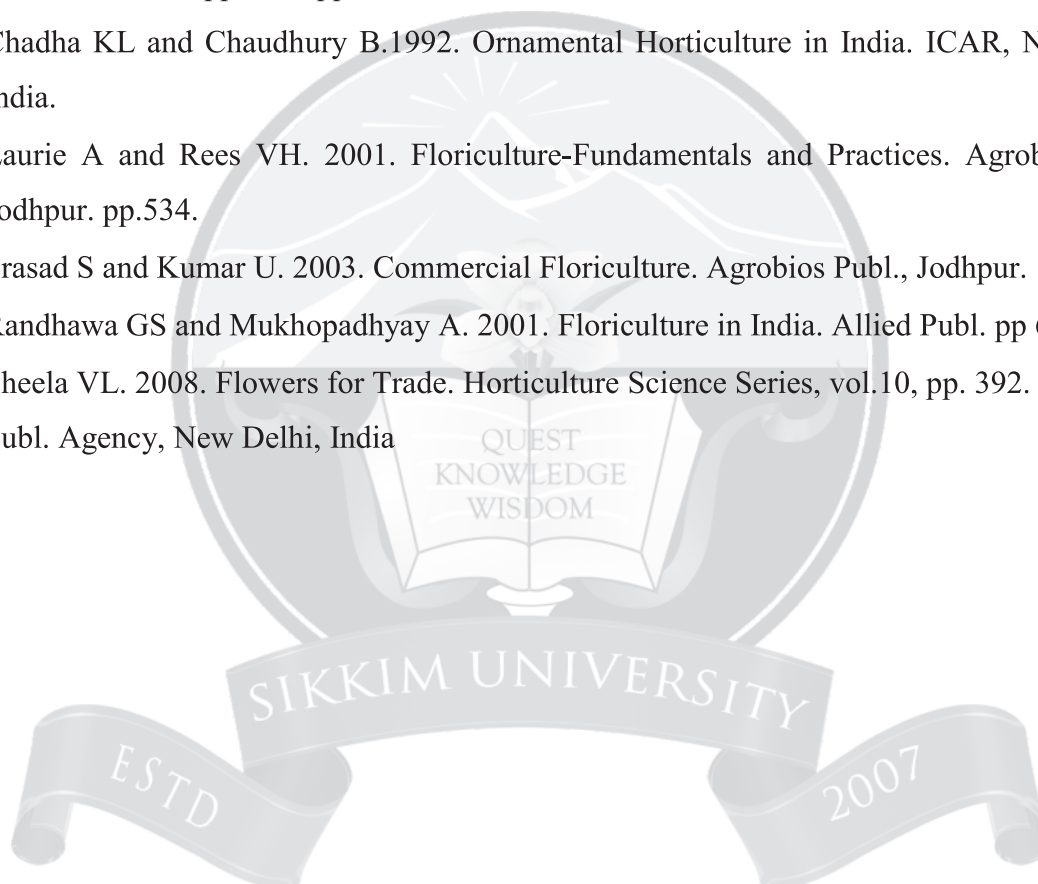
### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Arora JS. 2010. Introductory Ornamental Horticulture. Kalyani Publi. 6th Edition, pp. 230.
- Bhattacharjee SK. 2018. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Reprint, pp. 2065.
- Bose T K, Maiti RG, Dhua RS and Das P. 1999. Floriculture and landscaping. Naya Prokash, Kolkata, India.
- Bose TK and Yadav LP. 1989. Commercial Flowers. Naya Prokash, Kolkata, India.
- Chadha KL and Bhattacharjee S K. 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.
- Laurie A and Rees VH. 2001. Floriculture-Fundamentals and Practices. Agrobios Publ., Jodhpur. pp.534.
- Prasad S and Kumar U. 2003. Commercial Floriculture. Agrobios Publ., Jodhpur.
- Randhawa GS and Mukhopadhyay A. 2001. Floriculture in India. Allied Publ. pp 660.
- Sheela VL. 2008. Flowers for Trade. Horticulture Science Series, vol.10, pp. 392. New India Publ. Agency, New Delhi, India



**HOR-C-524 ORNAMENTAL GARDENING AND LANDSCAPING****Semester: Second semester****Total Marks: 100****L+T+P: 2+0+1= 3 Credits****Lecture: 30 Hrs + Tutorial: 0 Hrs+ Practical: 30 Hrs****Course Learning Outcomes**

CLO1: The students will be apprised of different types of gardens and have a thorough understanding of principles of landscape gardening

CLO2: Develop skills for landscaping under different situations and layout of garden components.

**Theory****Unit I**

Styles and types of gardens: Historical background of gardening, Importance, and scope of ornamental gardening, Styles of garden, Types of gardens: English, Mughal, Japanese, Persian, Spanish, Italian, French, Hindu, and Buddhist gardens. Specialized gardens: 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 II**

Garden components: Living garden components: 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 – Important grass genera and species, establishment and maintenance.

**Unit III**

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 IV

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 landscape principles;
- Case study;
- Site analysis, interpretation of map of different sites, use of GIS for selection;
- 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 shrubby borders;
- Project preparation on landscaping for different situations, creation of formal and informal gardens;
- Visit to parks and botanical gardens.

### Suggested Teaching Learning Strategies

- Lectures
- Group discussions
- Flip classes
- Assignment and group seminars
- Hands on training on different models of landscaping
- Exposure visits

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- 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.

**HOR-C-525 BREEDING OF ORNAMENTAL CROPS****Semester: Third Semester****Total Marks: 100****L+T+P: 2+0+1= 3 Credits****Lecture: 30 Hrs + Tutorial: 0 Hrs+ Practical: 30 Hrs****Course Learning Outcomes**

CLO1: Thorough understanding of principles of plant breeding and genetic mechanisms in different ornamental plants and flowers.

CLO2: Application of different breeding methods for improvement of ornamental crops.

CLO3: Develop the required skills in conventional and advanced breeding.

**Theory****Unit I**

Principles of plant breeding: Origin, evolution, distribution, introduction, domestication and conservation of ornamental crops. Intellectual Property and Plant Breeders Rights: Introduction and initiatives in IPR and PBR of ornamental crops.

**Unit II**

Genetic mechanisms and inheritance: Breeding objectives, reproductive barriers (Male sterility, incompatibility) in major ornamental crops. Inheritance of important traits, Genetic mechanisms associated with flower colour, size, form, doubleness, fragrance, plant architecture, post-harvest life, abiotic and biotic stress tolerance/ resistance.

**Unit III**

Breeding methods: Breeding methods suitable for sexually, asexually propagated flower crops, self- and cross-pollinated crops- pedigree selection, backcross, clonal selection, polyploidy and mutation breeding, heterosis and F1 hybrids.

**Unit IV**

Role of biotechnology: Role of biotechnology in improvement of flower crops including somaclonal variation, *in-vitro* mutagenesis, *in-vitro* selection, genetic engineering, molecular markers, etc.



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

### Practical

- Floral biology of important ornamental crops;
- Cytology and cytogenetics;
- Selfing and crossing procedures for important ornamental crops;
- Evaluation of hybrid progenies;
- Induction of mutants through physical and chemical mutagens;
- In-vitro selection, genetic engineering;
- Induction of polyploidy;
- DUS testing.

### Suggested Teaching Learning Strategies

- Lectures
- Group discussions
- Flip classes
- Assignment and student presentation
- Hands on training in different procedures

### Assessment Framework

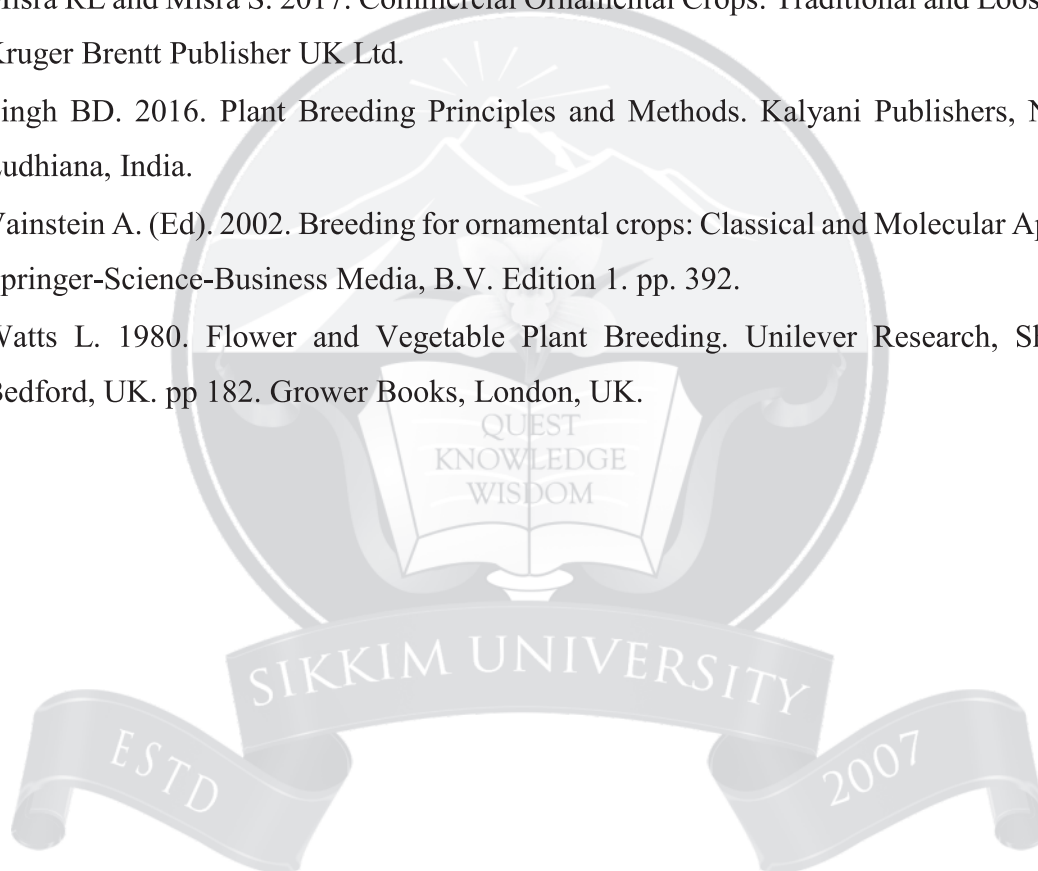
Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Bhattacharjee SK. 2018. Advances in Ornamental Horticulture. Pointer Publ., Reprint, 6 vols, pp. 2065.
- Bose TK and Yadav LP. 1989. Commercial flowers. Naya Prokash, Kolkata, India.

- Callaway DJ and Callaway MB. 2009. Breeding Ornamental Plants. Timber Press. Revised edition, pp. 359.
- 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 Choudhury B. 1992. Ornamental Horticulture in India. ICAR, New Delhi, India.
- Chaudhary RC. 1993. Introduction to Plant Breeding. Oxford & IBH Publ.
- Misra RL and Misra S. 2017. Commercial Ornamental Crops: Cut Flowers. Kruger Brentt Publisher UK Ltd. pp.584.
- Misra RL and Misra S. 2017. Commercial Ornamental Crops: Traditional and Loose Flowers. Kruger Brentt Publisher UK Ltd.
- Singh BD. 2016. Plant Breeding Principles and Methods. Kalyani Publishers, New Delhi Ludhiana, India.
- Vainstein A. (Ed). 2002. Breeding for ornamental crops: Classical and Molecular Approaches. Springer-Science-Business Media, B.V. Edition 1. pp. 392.
- Watts L. 1980. Flower and Vegetable Plant Breeding. Unilever Research, Sharnbrook, Bedford, UK. pp 182. Grower Books, London, UK.



**HOR-C-526 TURFGRASS MANAGEMENT****Semester: Third semester****Total Marks: 100****L+T+P: 2+0+1= 3 Credits****Lecture: 30 Hrs + Tutorial: 0 Hrs+ Practical: 30 Hrs****Course Learning Outcomes**

CLO1: Deep understanding and knowledge of different types of grasses and their management

CLO2: Developing skills for turfing of different arenas

CLO3: Develop required entrepreneurial acumen

**Theory****Unit I**

Prospects and basic requirement: History, present status and prospects of turf industry; basic requirements, site selection and evaluation, concepts of quality of soil pertaining to turf grass establishment, criteria for evaluation of turf quality.

**Unit II**

Types of turf grasses: Types, species, varieties, important breeders, grasses for different locations and conditions and their compatible groupings as per climatic conditions; Turfing for roof gardens.

**Unit III**

Operations and management: Preparatory operations; Turf establishment methods such as seeding, sprigging/ dibbling, plugging, sodding/ turfing, turf plastering, instant turfing (portable), hydroseeding, synthetic turfing. Turf management – Irrigation, drainage, nutrition, special practices like aerating, rolling, coring, dethatching, verticutting, soil top dressing, use of plant growth regulators and micronutrients, Turf mowing – mowing equipments, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs, standards for turf, use of recycled water, etc.

**Unit IV**

Making of different sports arenas: Establishment and maintenance of turfs for playgrounds, viz., golf, football, hockey, cricket, tennis, rugby, residential and public parks, turfing of Govt. and Corporate

office gardens, event specific preparation, turf colourants. Automation: Exposure to different tools, gadgets, machinery used in turf industry.

### Practical

- Identification of turf grasses and turf machinery;
- Soil preparation, turf establishment methods, provision of drainage;
- Layout of macro and micro irrigation systems;
- Water and nutrient management;
- Special practices – mowing, raking, rolling, soil top dressing, weed management;
- Biotic and abiotic stress management;
- Project preparation for turf establishment;
- Visit to parks, model cricket grounds and golf courses, airports, corporates, Govt. organizations;
- Rejuvenation of lawns;
- Turf economics.

### Suggested Teaching Learning Strategies

- Lectures
- Group discussions
- Flip classes
- Assignment and group seminars
- Hands on training of different techniques
- Exposure visits

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

## Suggested Readings

- Aldous D.1999. International Turf Management Handbook. CRC Press. pp.368.
- Beard JB. 1972. Turf Grass Science and Culture. Pearson. 1st edition, pp. 672.
- Chawla SL, Patil S, Patel MA, Patel RB and Patel RM. 2013. Turf grass Management. Published by NAU, Navsari.
- Emmons R. 2007. Turf grass Science and Management. Cengage Learning Publ. 4<sup>th</sup> edition, pp. 592.
- Nick-Christians. 2011. Fundamentals of Turf grass Management. Wiley; 4th Edition, pp. 424.
- Turgeon AJ. 1980. Turf grass Management. Reston Publ. Inc.

## HOR-C-527 CAD FOR LANDSCAPING

**Semester: Third semester**

**Total Marks: 100**

**L+T+P: 2+0+1= 3 Credits**

**Lecture: 30 Hrs + Tutorial: 0 Hrs+ Practical: 30 Hrs**

## COURSE LEARNING OUTCOMES

CLO1: The students will be able to use CAD and ARCHICAD for landscape planning and designing.

CLO2: Develop the adequate skills to create 3-D model to showcase interaction of different factors in landscape gardening.

### Theory

#### Unit I

CAD basics and applications: Principles of integrating the architecture and landscaping, Exposure to CAD (Computer Aided Designing) – Applications of CAD in landscape garden designing, 2D drawing by AUTOCAD, Creating legends for plant and non-plant components, Basics of Photoshop software in garden designing.

#### Unit II

2D drawing: 2D drawing methods, AUTOCAD Basics, Coordinate systems in AUTOCAD LT 2007, Point picking methods, Toolbars and Icons, File handling functions, Modifying tools, Modifying comments, Isometric drawings, Drafting objects. Using patterns in AUTOCAD drawing, Dimension

concepts, Hyperlinking, Script making, Using productivity tools, e-transmit file, making sample drawing for outdoor and indoor garden by AUTOCAD 2D Drawing techniques, Drawing web format design, Making layout.

### Unit III

3D drawing: 3D drawing methods, 3D drawing by ARCHICAD, 3D drawing by 3D MAX software, ARCHICAD file system, Tools and Infobox, modification tools, structural elements, GDL objects (Grid Dimensional Linking), Creation of garden components through ARCHICAD.

### Unit IV

Dimensioning and visualization: ARCHICAD organization tools, Dimensioning and detailing of designs, Landscape designing softwares and CD ROM for ornamental plant material (TRES, HIMFLORA, CAPSSA, etc), Attribute settings of components, Visualization tools for landscape preview, Data management, plotting and accessories for designing, Inserting picture using photoshop, Making sample drawing for outdoor and indoor gardens.

### Practical

- Practices in point picking methods, Using tool bars and icons, Using modifying tools and modifying comments;
- Isometric drawings, Using productivity tools;
- Drawing designs by AUTOCAD for home garden, institutional garden and special types of garden;
- Using tools and info-box for 3D drawing, Creation of garden components with ARCHICAD;
- Organization, dimensioning, detailing and visualization tools with ARCHICAD;
- Using Photoshop package for 3D picture insertion;

### Suggested Teaching Learning Strategies

- Lectures
- Group discussions
- Flip classes
- Assignment and group seminars
- Hands on training of different techniques



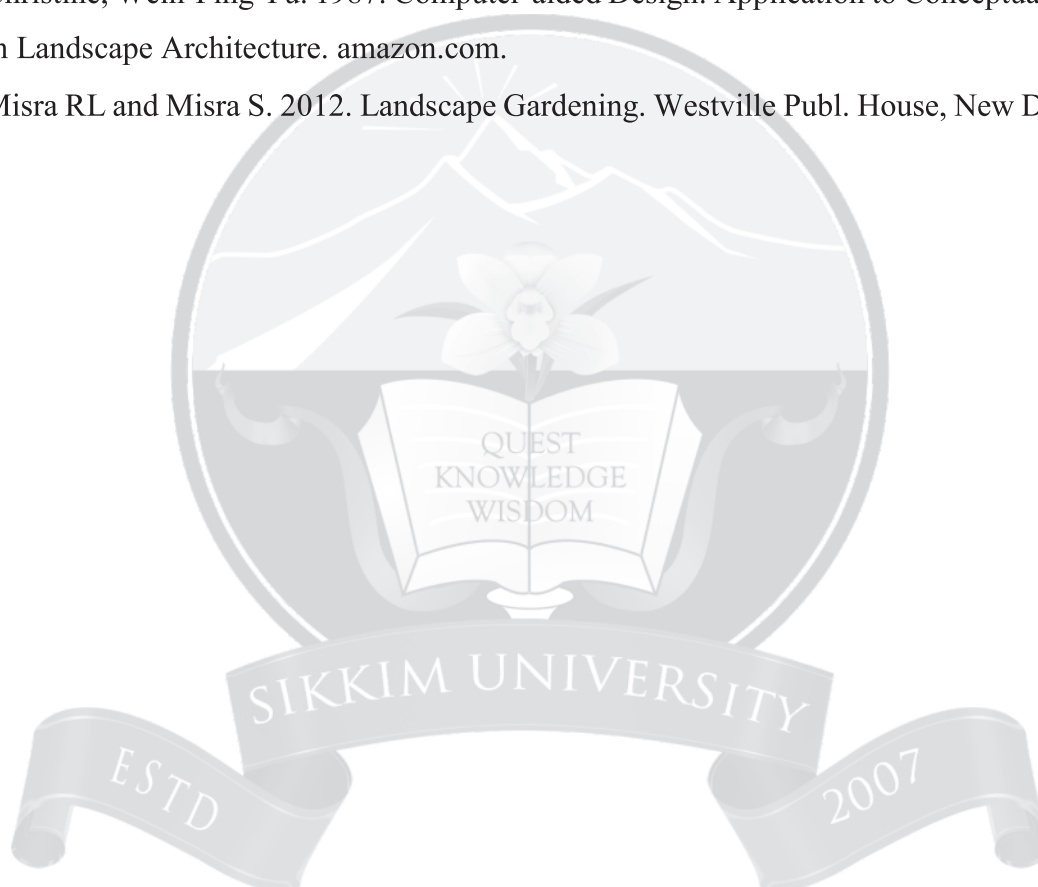
### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Christine, Wein-Ping Yu. 1987. Computer-aided Design: Application to Conceptual Thinking in Landscape Architecture. amazon.com.
- Misra RL and Misra S. 2012. Landscape Gardening. Westville Publ. House, New Delhi, India



**PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS  
SEMESTER-I**

Code	Course Title	Type of Course	Credits
HOR-SU-541	Experimental Designs	Supporting	2+0+1
HOR-SU-542	Biotechnology for Crop Improvement	Supporting	2+0+1
HOR-CC-551	Intellectual Property and Its Management in Agriculture	Common	1+0+0
HOR-CC-552	Basic Concepts in Laboratory Techniques	Common	0+0+1
HOR-CC-553	Library and Information Services	Common	0+0+1
HOR-CC-554	Technical Writing and Communications Skills	Common	0+0+1
HOR-CC-555	Agricultural Research, Research Ethics, and Rural Development Programmes	Common	1+0+0
HOR-V-556	Indigenous Traditional Knowledge in Horticulture	Value added	4+0+0
HOR-V-557	Cyber security	Value added	2+0+0
HOR-S-558	Value addition of Horticultural Crops	Skill Enhancement	1+0+1
HOR-S-559	Diagnosis of disease and identification of insect-pest in Horticulture crops	Skill Enhancement	1+0+1
	Total		21

**SEMESTER-II**

Code	Course Title	Type of Course	Credits
HOR-C-531	Production of Plantation Crops	Major	2+0+1
HOR-C-532	Production of Spices Crops	Major	2+0+1
HOR-C-533	Production of medicinal and Aromatic Crops	Major	2+0+1
HOR-C-534	Biochemistry of Plantation, Spices, Medicinal, and Aromatic Crops	Major	2+0+1
	HOR-C-501/511/521	Minor	2+0+1
	HOR-C-502/512/522	Minor	2+0+1
	HOR-C-503/513/523	Minor	2+0+1
	Total		21

**SEMESTER-III**

Code	Course Title	Type of Course	Credits
HOR-C-535	Breeding of Plantation and Spices Crops	Major	2+0+1
HOR-C-536	Breeding of Medicinal and Aromatic Crops	Major	2+0+1
HOR-C-537	Growth and Development of Plantation, Spices, Medicinal, and Aromatic Crops	Major	2+0+1
HOR-C-591	Master's Seminar	Major	0+0+1
HOR-R-599-I	Master's Research – I	Research	0+0+10
	Total		20

**SEMESTER-IV**

Code	Course Title	Type of Course	Credits
HOR-R-599-II	Master's Research – II	Research	0+0+20

**HOR-C-531 PRODUCTION OF PLANTATION CROPS****Semester: Second semester****Total Marks: 100****L+T+P: 2+0+1=3****Credit lecture: 30 hrs+ Tutorial: 0 + Practical: 30 Hrs****Course Learning Outcomes**

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

CLO1: Develop the technical skills in commercial cultivation of plantation crops

CLO2: Be able to start plantation crop-based enterprises

**Theory****Unit I**

Role of plantation crops: Role of plantation crops in national economy, area-production statistics at national and international level, classification, clean development mechanism and carbon sequestration potential of plantation crops. Export potential: Export potential, problems and prospects and IPR issues in plantation crops. Promotional programmes: Role of commodity boards and directorates in the development programmes of plantation crops.

**Unit II**

Varietal wealth: Botany, taxonomy, species, cultivars and improved varieties in plantation crops.

Propagation and nursery management: Plant multiplication including *in-vitro* multiplication, nursery techniques and nursery management in plantation crops.

**Unit III**

Agro techniques: Systems of cultivation, cropping systems, multitier cropping, climate and soil requirements, systems of planting, high density planting, nutritional requirements, water requirements, fertigation, moisture conservation, role of growth regulators, macro and micro nutrients, nutrient deficiency symptoms, physiological disorders, shade regulation, weed management, training and pruning, crop regulation, plant protection, management of drought, precision farming.

**Unit IV**

Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons and mechanized harvesting in plantation crops. Post harvest management: Post harvest handling including primary processing, grading, packaging, storage and benefit cost analysis of plantation crops.

**Crops**

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

**Practical**

- Description of botanical and varietal features;
- Selection of mother palms and seedlings;
- Nursery techniques;
- Soil and water conservation measures;
- Nutrient deficiency symptoms;
- Manuring practices;
- Pruning and training methods;
- Maturity standards;
- Harvesting;
- Project preparation for establishing plantations;
- GAP in plantation crops;
- Exposure visits to commercial plantations, research institutes.

**Suggested Teaching Learning Strategies**

- Lecture
- Assignment (Reading/ Writing)
- Demonstration
- Exposure visits

**Assessment Framework**

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

**Suggested Readings**

- Afoakwa EO. 2016. *Cocoa Production and Processing Technology*. CRC Press.
- Anonymous. 1985. *Rubber and its Cultivation*. The Rubber Board of India.
- Chopra VL and Peter KV. 2005. *Handbook of Industrial Crops*. Panima.

- Choudappa P, Anitha K, Rajesh MK and Ramesh SV. 2017. *Biotechnology of Plantation Crops*.
- Daya Publishing House, New Delhi
- Choudappa P, Niral V, Jerard BA and Samsudeen K. 2017. *Coconut*. Daya Publishing House, New Delhi.
- *e-manual* on Advances in Cashew Production Technology. ICAR –Directorate of Cashew Research, Puttur –574 202, DK, Karnataka.
- Harler CR. 1963. *The Culture and Marketing of Tea*. Oxford Univ. Press.
- Joshi P. 2018. *Text Book on fruit and plantation crops*. Narendra Publishing House, New Delhi
- Kurian A and Peter KV. 2007. *Commercial Crops Technology*. New India Publ. Agency.
- Nair MK, Bhaskara Rao EVV, Nambia KKN and Nambiar MC. 1979. *Cashew*. CPCRI, Kasaragod.
- Panda H. 2013. *The Complete Book on Cashew*. Asia Pacific Business Press Inc.
- Panda H. 2016. *The Complete Book on Cultivation and Manufacture of Tea* (2nd Revised Edition). Asia Pacific Business Press Inc.
- Peter KV. 2002. *Plantation Crops*. National Book Trust.
- Pillay PNR. 1980. *Handbook of natural rubber production in India*. Rubber Research Institute, Kottayam. pp.668.
- Pradeepkumar T, Suma B, Jyothibhaskar and Satheesan KN. 2007. *Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.
- Ramachandra *et al.* 2018. *Breeding of Spices and Plantation crops*. Narendra Publishing House, New Delhi.
- Ranganathan V. 1979. *Hand Book of Tea Cultivation*. UPASI, Tea Res. Stn. Cinchona.
- Sera T, Soccol CR, Pandey A, Roussos S *Coffee Biotechnology and Quality*. Springer, Dordrecht.
- Sethuraj MR and Mathew NT. 1992. *Natural Rubber: Biology, Cultivation and Technology (Developments in Crop Science)*. Elsevier Science.
- Sharangi AB and Datta S. 2015. *Value Addition of Horticultural crops: Recent trends and Future directions*. SPRINGER; ISBN: 978-81-322-2261-3.
- Sharangi AB and Acharya SK. 2008. *Quality management of Horticultural crops*. Agrotech Publishing House, Udaipur; ISBN: 81-8321-090-2.

- Srivastava HC, Vatsya and Menon, KKG. 1986. *Plantation Crops – Opportunities and Constraints*. Oxford and IBH.

### **HOR-C-532 PRODUCTION OF SPICE CROPS**

**Semester: Second semester**

**Total Marks: 100**

**L+T+P: 2+0+1=3**

**Credit lecture: 30 hrs+ Tutorial: 0+ Practical: 30 Hrs**

#### **Course Learning Outcomes**

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

CLO1: Develop the technical skill in commercial cultivation of spice crops

CLO2: Be able to start spice-based enterprises

#### **Theory**

##### **Unit I**

Role of Spice crops: Introduction, importance of spice crops, pharmaceutical significance, historical accent, present status – national and international, future prospects, role of Spices board and other development agencies.

##### **Unit II**

Classification of spice crops: Major spices, minor spices, seed spices, tree spices, herbal spices. Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in spice crops.

##### **Unit III**

Propagation and nursery management: Seed, vegetative and micropropagation methods, nursery techniques and nursery management practices. Agro techniques: Climatic and soil requirements, site selection, layout, sowing/ planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, plant protection, precision farming, physiological disorders, protected cultivation.

##### **Unit IV**

Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons, mechanized harvesting. Post harvest management: Post harvest management including primary processing, grading, packaging and storage, GMP in major spice crops.



## Crops

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

## 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 spice crops;
- GMP in spice crops;
- Short term experiments on spice crops;
- Exposure visits to spice farms, research institutes

## Suggested Teaching Learning Strategies

- Lecture
- Assignment (Reading/ Writing)
- Demonstration
- Exposure visits

## Assessment Framework

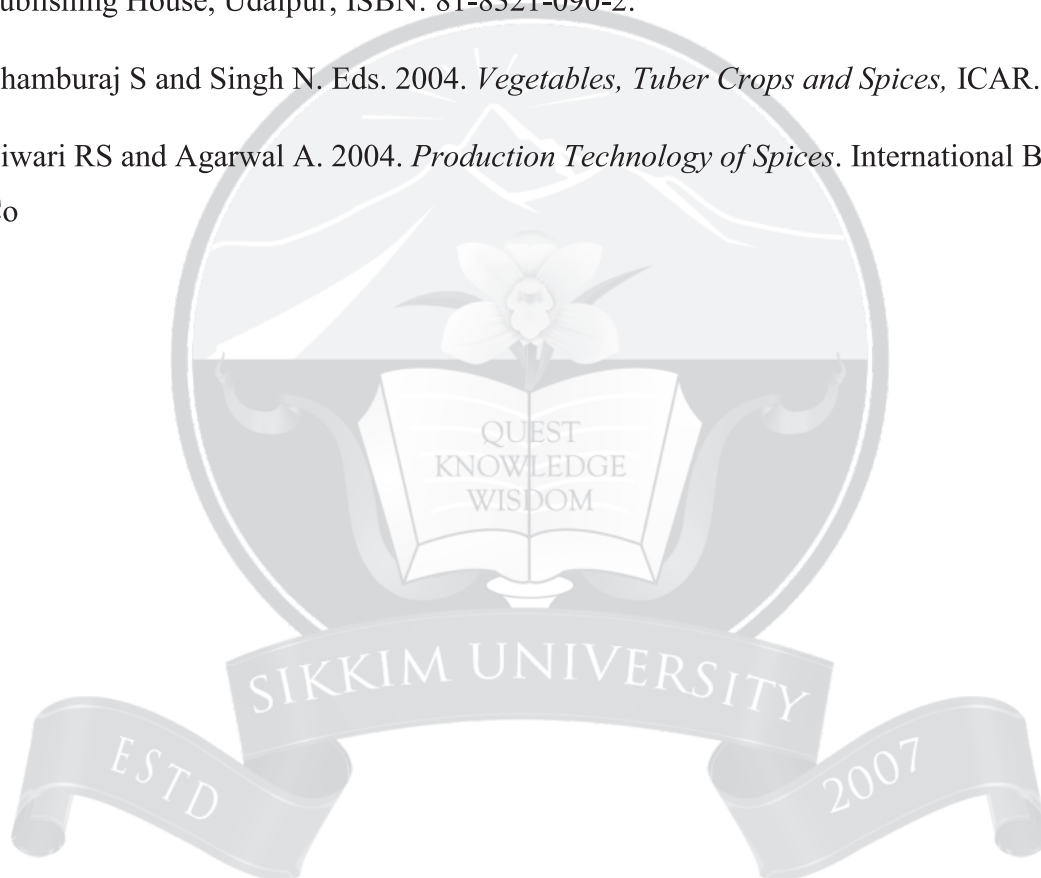
Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

## Suggested Readings

- 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.
- Kumar NA, Khader P, Rangaswami and Irulappan I. 2000. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants*. Oxford and IBH.
- Nybe EV, Miniraj N and Peter KV. 2007. *Spices*. New India Publ. Agency.
- Parthasarthy VA, Kandiannan V and Srinivasan V. 2008. *Organic Spices*. New India Publ. Agency.
- Peter KV. 2001. *Hand Book of Herbs and Spices*. Vols. I-III. Woodhead Publ. Co. UK and CRC USA.
- Ponnuswami V *et al.* 2018. *Medicinal Herbs and Herbal Cure*. Narendra Publishing House, New Delhi.
- Pruthi JS. Ed. 1998. *Spices and Condiments*. National Book Trust.
- Pruthi JS. 2001. *Minor Spices and Condiments- Crop Management and Post Harvest Technology*. ICAR.
- Purseglove JW, Brown EG, Green CL and Robbins SRJ. Eds. 1981. *Spices*. Vols. I, II. Longman.
- 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 genus Elettaria*. 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 Academic Press (Tylor and Francis Groups), New Jersey, USA. Sharangi AB. 2018. Indian Spices “*The legacy, production and processing of India’s treasured export.*” Springer International publishing AG, Part of Springer Nature 2018, Cham, Switzerland.
- Sharangi AB and Datta S. 2015. *Value Addition of Horticultural crops: Recent trends and Future directions*. SPRINGER; ISBN: 978-81-322-2261-3.
- Sharangi AB and Acharya SK. 2008. *Quality Management of Horticultural crops*. Agrotech Publishing House, Udaipur; ISBN: 81-8321-090-2.
- Thamburaj S and Singh N. Eds. 2004. *Vegetables, Tuber Crops and Spices*, ICAR.
- Tiwari RS and Agarwal A. 2004. *Production Technology of Spices*. International Book Distr. Co



**HOR-C-533 PRODUCTION OF MEDICINAL AND AROMATIC CROPS****Semester: Second semester****Total Marks: 100****L+T+P: 2+0+1=3****Credit lecture: 30 hrs+ Tutorial: 0 + Practical: 30 Hrs****Course Learning Outcomes**

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

CLO1: Develop the technical skill in commercial cultivation of medicinal and aromatic crops

CLO2: Be able to start medicinal and aromatic crop-based enterprises

**Theory****Unit I**

Classification of medicinal and aromatic crops: Importance of medicinal plants, Importance of aromatic plants, Role in national economy, utility sectors of medicinal and aromatic crops, classification of medicinal and aromatic crops, role of institutions, Medicinal Plant Board and NGO's in research and development of medicinal and aromatic crops.

**Unit II**

Medicinal and plant based industry: Indian system of medicine, traditional systems of medicine, tribal medicine, medicinal industry, source of medicinal plants, area, production, export and import of major crops, problems, prospects and challenges, IPR issues.

Aromatic plant based industry: Essential oils, classification, physical and chemical properties and storage of essential oils. Indian perfumery industry, area, production, export and import status of major aromatic crops, history and advancements, problems, prospects and challenges, IPR issues.

**Unit III**

Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in medicinal and aromatic crops. Propagation and nursery management: Seed, vegetative and micropropagation methods, nursery techniques and nursery management practices.

**Unit IV**

Agro techniques: Climatic and soil requirements, site selection, layout, sowing/ planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, plant protection. Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons in medicinal and aromatic crops. Post harvest management: Post harvest management including primary processing, extraction, grading, packaging and storage, GMP in medicinal and aromatic crops.

## Crops

**A. Medicinal crops:** Senna, periwinkle, medicinal coleus, aswagandha, glory lily, sarpagandha, *Dioscorea* sp., *Aloe vera*, *Andrographis paniculata*, *Digitalis*, medicinal solanum, isabgol, opium poppy, safedmusli, *Stevia rebaudiana*, *Mucuna pruriens*, *Piper longum*, *Plumbago zeylanica*

**B. Aromatic crops:** Palmarosa, lemongrass, citronella, vetiver, mentha, patchouli, sweet flag, jasmine, geranium, artemisia, lavender, *Ocimum* sp., eucalyptus, sandal

## Practical

- Description of botanical and varietal features;
- Nursery techniques;
- Lay out and planting;
- Manuring practices;
- Maturity standards;
- Harvesting;
- Primary processing;
- Extraction of oils;
- Herbarium preparation;
- Project preparation for establishing herbal gardens;
- GAP in medicinal and aromatic crops;
- GMP in medicinal and aromatic crops;
- Exposure visits to institutes, herbal gardens and industries.

## Suggested Teaching Learning Strategies

- Lecture
- Assignment (Reading/ Writing)
- Demonstration
- Exposure visits

**Assessment Framework**

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

**Suggested Readings**

- 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.
- 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.
- Ramawat KG and Merillon JM. 2003. *BioTechnology – Secondary Metabolites*. Oxford and IBH.
- Shankar SJ. 2018. *Comprehensive post harvest technology of flowers, medicinal and aromatic plants*. Narendra Publishing House, New Delhi.



- Skaria PB, Samuel M, Gracy Mathew, Ancy Joseph, Ragina Joseph. 2007. *Aromatic Plants*. New India Publ. Agency.

## **HOR-C-534 BIOCHEMISTRY OF PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS**

**Semester: Second semester**

**Total Marks: 100**

**L+T+P: 2+0+1=3**

**Credit lecture: 30 hrs+ Tutorial: 0 + Practical: 30 Hrs**

### **Course Learning Outcomes**

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

CLO1: Develop the technical know-how on postharvest biochemistry of plantation, spice, medicinal and aromatic crops.

### **Theory**

#### **Unit I**

Physiological and biochemical changes: Maturity indices, changes during ripening, processing, factors affecting quality. Secondary metabolites and their biosynthetic pathways, factors affecting production of secondary metabolites. Contaminants: Adulterants, and substitutes, sources of contamination microbial, heavy metal, pesticide residues in PSMAAs.

#### **Unit II**

Value added products: Fixed oils, essential oils, dyes, oleoresins, aroma chemicals and other value added products, their content, storage, medicinal and pharmacological properties, use in the food, flavor perfumery and pharmaceutical industries. Quality standards: Quality standards of raw materials and finished products.

#### **Unit III**

Extraction methods: Basic and advanced extraction techniques in PSMAAs- Soxhlet, SCFE, Membrane extraction. Chemical characterization-HPTLC, GCMS, LCMS, NMR.

#### **Unit IV**

Plant tissue culture: Plant tissue cultures in the industrial production of bioactive plant metabolites. Cell suspension culture systems for large scale culturing of plant cells and production of secondary metabolites. Advantages of cell culture over conventional extraction techniques.

**Practical**

- Biochemical characterization;
- Detection of adulterants and substitutes;
- Extraction and quantification of secondary metabolites;
- Chromatographic separation of the products;
- Quality assurance;
- Testing the product;
- Exposure visit to leading industries;
- Assessment of antimicrobial properties;
- *In-vitro* production of secondary metabolites.

**Suggested Teaching Learning Strategies**

- Lecture
- Assignment (Reading/ Writing)
- Demonstration
- Exposure visits

**Assessment Framework**

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

**Suggested Readings**

- Afoakwa EO. 2016. Cocoa Production and Processing Technology. CRC Press.
- Daniel M and Mammen D. 2016. Analytical methods for medicinal plants and economic botany. Scientific publishers.
- Das K. 2013. Essential oils and their applications. New India Publishing Agency, New Delhi.
- E-manual on Advances in Cashew Production Technology. ICAR -Directorate of Cashew Research, Puttur –574 202, DK, Karnataka.

- Hammon JM and Yusibov V. 2000. Plant Biotechnology: New Products and application. Springer- Verlag. Orhan I. 2012. Biotechnological Production of Plant Secondary Metabolites. Bentham Science Publishers.
- Panda H. 2013. The Complete Book on Cashew. Asia Pacific Business Press Inc.
- Panda H. 2016. The Complete Book on Cultivation and Manufacture of Tea (2nd Revised Edition). Asia Pacific Business Press Inc.
- Pillay PNR. 1980. Handbook of Natural Rubber Production in India. Rubber Research Institute, Kottayam. pp.668.
- Raaman N. 2006. Phytochemical techniques. New India Publishing Agency, New Delhi.
- Raju R Wadekar. 2015. Pharmacognosy and phytochemistry, Event publishing house.
- Ramawat KG. 2007. Biotechnology: secondary metabolites: plants and microbes. Science Publishers.
- Sethuraj MR and Mathew NT. 1992. Natural Rubber: Biology, Cultivation and Technology (Developments in Crop Science). Elsevier Science.
- Shah B and Seth AK. 2005. Text book of Pharmacognosy and Phytochemistry. Cbs Publishers and distributors, New Delhi.
- Shankar SJ. 2018. Comprehensive post harvest technology of flowers, medicinal and aromatic plants. Narendra Publishing House, New Delhi
- Shukla YM. 2009. Plant secondary metabolites. New India Publishing Agency, New Delhi
- Syed Aftab Iqbal and Noor Ahmed Khan. 1993. Text book of Phytochemistry. Discovery Publishing house Pvt. Ltd.
- Tiwari C. 2018. Antimicrobial properties of Medicinal plants. Narendra Publishing House, New Delhi.
- Trivedi C. 2004. Herbal drugs and biotechnology. Pointer Publishers.
- Waghulkar VM. 2012. Quality assurance techniques in pharmaceuticals. New India Publishing Agency, New Delhi.

**HOR-C-535 BREEDING OF PLANTATION AND SPICE CROPS****Semester: Third semester****Total Marks: 100****L+T+P: 2+0+1=3****Credit lecture: 30 hrs+ Tutorial: 0 + Practical: 30 Hrs****Course Learning Outcomes**

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

CLO1: Develop the technical skill in breeding of plantation and spice crops

CLO2: Be able to start plantation and spice crop-based seed production/ nursery centres

**Theory****Unit I**

Species and cultivar diversity: Floral and reproductive biology, cytogenetics, male sterility, incompatibility, wild and cultivated species, popular cultivars. Germplasm evaluation: Survey, collection, conservation and evaluation of germplasm.

**Unit II**

Breeding objectives: Breeding objectives/ goals on the basis of yield, quality, stress tolerance, adaptation. Breeding methods: Approaches for crop improvement, introduction, selection, hybridization, mutation breeding, polyploidy breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses.

**Unit III**

Breeding achievements: Breeding achievements in terms of released varieties, parentage, salient features. Future thrusts: Molecular breeding and biotechnological approaches, marker-assisted selection, bioinformatics, breeding for climate resilience

**Unit IV****Crops**

**A. Plantation crops:** Coconut, Arecanut, Cashew, Cocoa, Rubber, Oil palm, Coffee, Tea, Palmyrah, Betel vine

**B. Spice crops:** Black pepper, small and large cardamom, Ginger, Turmeric, Fenugreek, Coriander, Fennel, Cumin, Ajwain, Garlic, Nutmeg, Cinnamon, Clove, Allspice, Garcinia, Tamarind

**Practical**

- Characterization and evaluation of germplasm;
- Floral biology, anthesis; pollen behaviour, fruit set;
- Practices in hybridization, selfing and crossing techniques;

- Polyploidy breeding;
- Mutation breeding;
- Induction of somaclonal variation and screening the variants;
- Evaluation of biometrical traits and quality traits;
- Salient features of improved varieties and cultivars;
- Screening for biotic and abiotic stresses;
- Bioinformatics;
- Exposure visits to research institutes for plantation and spice crops.

### Suggested Teaching Learning Strategies

- Lecture
- Assignment (Reading/Writing)
- Demonstration
- Exposure visits

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Afoakwa EO. 2016. Cocoa Production and Processing Technology. CRC Press.
- Anonymous. 1985. Rubber and its Cultivation. The Rubber Board of India.
- Chadha KL, Ravindran PN and Sahijram L. 2000. Biotechnology in Horticultural and Plantation Crops. Malhotra Publ. House.
- Chadha KL. 1998. Advances in Horticulture. Vol. IX,X. Plantation and Spices Crops. Malhotra Publishing House, New Delhi.
- Chadha KL and Rethinam P. Eds. 1993. Advances in Horticulture. Vol. IX. Plantation Crops Panama International Publ. (Indian Ed.).
- Choudappa P, Anitha K, Rajesh MK and Ramesh SV. 2017. Biotechnology of Plantation Crops. Daya Publishing House, New Delhi.

- Damodaran V K, Vilaschandran T and Valsalakumari PK. 1979. Research on Cashew in India. KAU, Trichur.
- Devi AR, Sharangi AB, Acharya SK and Mishra GC. 2017. Coriander in Eastern India: The landraces and genetic diversity. Krishi Sanskriti Publications. New Delhi. ISBN: 978-93-85822-48-3.
- E-manual on Advances in Cashew Production Technology. ICAR –Directorate of Cashew Research, Puttur –574 202, DK, Karnataka
- Nybe EV, MiniRaj N and Peter KV. 2007. Spices. New India Publishing Agency.
- Panda H. 2013. The Complete Book on Cashew. Asia Pacific Business Press Inc.
- Panda H. 2016. The Complete Book on Cultivation and Manufacture of Tea (2nd Revised Edition). Asia Pacific Business Press Inc.
- Pillay PNR. 1980. Handbook of Natural Rubber Production in India. Rubber Research Institute, Kottayam. pp. 668.
- Ponnuswami et al. 2018. Blossom biology of Horticultural crops. Narendra Publishing House, New Delhi.
- Ponnuswami et al. 2018. Botany of Horticultural crops. Narendra Publishing House, New Delhi
- Ponnuswami et al. 2018. Spices. Narendra Publishing House, New Delhi.
- Ramachandra et al. 2018. Breeding of Spices and Plantation Crops. Narendra Publishing House, New Delhi
- Ravindran PN. 2002. Cardamom, the genus Elettaria. 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



**HOR-C-536 BREEDING OF MEDICINAL AND AROMATIC CROPS****Semester: Third semester****Total Marks: 100****L+T+P: 2+0+1=3****Credit lecture: 30 hrs+ Tutorial: 0 + Practical: 30 Hrs****Course Learning Outcomes**

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

CLO1: Develop the technical skill in breeding of medicinal and aromatic crops

CLO2: Be able to start medicinal and aromatic crop-based seed production/ nursery centres

**Theory****Unit I**

Species and cultivar diversity: Floral and reproductive biology, cytogenetics, male sterility, incompatibility, wild and cultivated species, popular cultivars. Germplasm evaluation: Survey, collection, conservation and evaluation of germplasm, IPR issues.

**Unit II**

Breeding objectives: Breeding problems in medicinal and aromatic crops. Genetics of active principles, breeding objectives/ goals on the basis of yield, quality, stress tolerance, adaptation. Breeding methods: Approaches for crop improvement, introduction, selection, hybridization, mutation breeding, polyploidy breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses.

**Unit III**

Breeding achievements: Breeding achievements in terms of released varieties, parentage, salient features. Future thrusts: Molecular breeding and biotechnological approaches, marker-assisted selection, bioinformatics, breeding for climate resilience.

**Unit IV****Crops**

**A. Medicinal crops:** *Cassia angustifolia*, *Catharanthus roseus*, *Gloriosa superba*, *Coleus forskohlii*, *Stevia rebaudiana*, *Withania somnifera*, *Papaver somniferum*, *Plantago ovata*, *Chlorophytum* sp., *Rauvolfia serpentina*, *Aloe vera*, *Piper longum*, *Plumbago zeylanica*

**B. Aromatic crops:** Mint, geranium, patchouli, lemon grass, palmarosa, citronella, vetiver, Artemisia, ocimum, lavender, *Kaempferia galanga*, eucalyptus

**Practical**

- Description of botanical features;
- Cataloguing of cultivars, varieties and species in medicinal and aromatic crops;
- Floral biology;
- Selfing and crossing;
- Evaluation of hybrid progenies;
- Induction of economic mutants;
- High alkaloid and high essential oil mutants;
- Evolution of mutants through physical and chemical mutagens;
- Introduction of polyploidy;
- Screening of plants for biotic and abiotic stress;
- *In-vitro* breeding in medicinal and aromatic crops.

**Suggested Teaching Learning Strategies**

- Lecture
- Assignment (Reading/ Writing)
- Demonstration
- Exposure visits

**Assessment Framework**

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

**Suggested Reading**

- Chadha KL and Gupta, R. 1995. Advances in Horticulture. Vol. XI. Malhotra Publ. House.
- Farooqi AA, Khan MM and Vasundhara M. 2001. Production Technology of Medicinal and Aromatic Crops. Natural Remedies Pvt. Ltd.
- Gupta R.K. 2010. Medicinal and Aromatic plants. CBS publications
- Jain SK. 2000. Medicinal Plants. National Book Trust.
- Julia F and Charters MC. 1997. Major Medicinal Plants – Botany, Cultures and Uses. Thomas Publ.

- Kurian A and Asha Sankar M. 2007. Medicinal Plants. Horticulture Science Series, New India Publ. Agency.
- Ponnuswami et al. 2018. Blossom biology of Horticultural crops. Narendra Publishing House, New Delhi
- Ponnuswami et al. 2018. Botany of Horticultural crops. Narendra Publishing House, New Delhi
- Ponnuswami et al. 2018. Medicinal Herbs and Herbal Cure. Narendra Publishing House, New Delhi
- Waghulkar VM. 2012. Quality assurance techniques in pharmaceuticals. New India Publishing Agency, New Delhi

### **HOR-C-537 GROWTH AND DEVELOPMENT OF PLANTATION, SPICE, MEDICINAL AND AROMATIC CROPS**

**Semester: Third semester**

**Total Marks: 100**

**L+T+P: 2+0+1=3**

**Credit lecture: 30 hrs+ Tutorial: 0 + Practical: 30 Hrs**

#### **Course Learning Outcome**

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

CLO1: Have thorough understanding on growth and development of PSMA crops

CLO2: Will enable them to formulate crop regulation strategies for productivity enhancement.

#### **Theory**

##### **Unit I**

Stages of growth: Growth and development, definitions, components, photosynthetic productivity, different stages of growth, growth curves, growth analysis, morphogenesis in PSMA. Growth pattern: in annual, semi-perennial and perennial crops, growth dimorphism, environmental impact on growth and development: effect of light, temperature, photoperiod. Assimilate partitioning: Assimilate partitioning during growth and development, influence of water and mineral nutrition.

##### **Unit II**

Canopy management: Canopy management for conventional and high density planting pruning, training, chemicals, crop regulation for year round and off season production in PSMA. Plant bio

regulators: plant bio regulators- auxins, gibberellins, cytokinins, ethylene, inhibitors and retardants, basic functions, biosynthesis and role in crop growth and development.

### Unit III

Vegetative phase: Developmental physiology and biochemistry during dormancy, bud break, juvenility.

Flowering and fruit set, Physiology of flowering, photoperiodism, vernalisation, effect of temperature, heat units, thermoperiodism, pollination, fertilisation, fruit set, fruit drop, fruit growth, ripening, seed development in PSMAAs.

### Unit IV

Growth and development process during stress: Growth and development process during stress, production of secondary metabolites, molecular and genetic approaches in growth and development.

### Practical

- Dormancy mechanisms in seeds, seed rhizomes;
- Techniques of growth analysis;
- Evaluation of photosynthetic efficiency under different environments;
- Technologies for crop regulation in cashew, coffee, cocoa, etc.;
- Root shoot studies, flower thinning, fruit thinning;
- Crop regulation for year round production;
- Use of growth regulators in PSMA crops.

### Suggested Teaching Learning Strategies

- Lectures
- Assignments (Reading/ Writing)
- Demonstrations
- Exposure visits

### Assessment Framework

Assessment	Written Modes	Oral Modes
Formative	Class tests, Objective tests, Class assignments, Home assignments, Report writing, Article writing	Oral Test, Viva-Voce, Class presentations, Field Assignments
Summative	Semester-end examinations conducted by the university will be considered as the mode of summative assessment.	

**Note:** Concern teacher can choose any mode of formative assessment as per the nature of the CLO

### Suggested Readings

- Afoakwa EO. 2016. Cocoa Production and Processing Technology. CRC Press
- E- manual on Advances in Cashew Production Technology. ICAR -Directorate of Cashew Research, Puttur –574 202, DK, Karnataka
- Epstein E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. Wiley.
- Fosket DE. 1994. Plant Growth and Development: A Molecular approach. Academic Press.
- Leopold AC and Kriedemann PE. 1985. Plant Growth and Development. 3rd Ed. McGraw-Hill
- Panda H. 2013. The Complete Book on Cashew. Asia Pacific Business Press Inc.
- Panda H. 2016. The Complete Book on Cultivation and Manufacture of Tea (2nd Revised Edition). Asia Pacific Business Press Inc.
- Ravindran PN. 2000. Black pepper, *Piper nigrum*. CRC press
- Ravindran PN. 2002. Cardamom, the genus *Elettaria*. 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
- Roberts JS Downs and P Parker. 2002. Plant Growth Development. In: Plants (L. Ridge, Ed.), pp. 221-274, Oxford University Press
- Salisbur FB and Ross CW. 1992. Plant Physiology. 4th Ed. Wadsworth Publ.
- Sethuraj MR and Mathew NT. 1992. Natural Rubber: Biology, Cultivation and Technology (Developments in Crop Science). Elsevier Science.