



# MSc HORTICULTURE (2019-21) CURRICULUM BOOK

Department of Horticulture  
School of Life Sciences  
Central University of Tamil Nadu

July 2019



## **MSc Horticulture (2019-21)**

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# DEPARTMENT OF HORTICULTURE

## ABOUT

### INAUGURAL YEAR

2019

### PROGRAMMES OFFERED

MSc Horticulture (Fruit Science/Vegetable Science/Floriculture and Landscaping)

### NOMENCLATURE AND COMMENCEMENT

These rules and regulations shall govern the post graduate studies in horticulture leading to the award of the following degrees.

1. **Master of Science (Horticulture) in Fruit Science**
2. **Master of Science (Horticulture) in Vegetable Science**
3. **Master of Science (Horticulture) in Floriculture and Landscaping Science**

All the three programs shall come into force with effect from the academic year 2019 – 2020.

### DEFINITIONS

- An “Academic Year” shall consist of two semesters.
- “Subject” means a unit of instruction to be covered in a semester having specific number, title and credits.
- “Credit hour” means, one hour lecture plus two hours of library or homework or two hours of laboratory/field practical per week in a semester.
- “Grade Point of a subject” means the value obtained by dividing the percentage of marks earned in a subject by 10 and the Grade Point is expressed on a 10 point scale.
- “Credit Point” means the grade point multiplied by credit hours.
- “Grade Point Average” (GPA) means the quotient of the total credit points obtained by a student in various subjects at the end of each semester, divided by the total credit hours taken by the student in that semester. The grading is done on a 10 point scale and the GPA has to be corrected to two decimals.
- “Overall Grade Point Average” (OGPA) means the quotient of cumulative credit points obtained by a student in all the subjects taken from the beginning of the first semester of the year divided by the total credit hours of all the subjects which he/she had completed up to the end of a specified semester and determines the overall performance of a student in all subjects during the period covering more than one semester. The OGPA has to be arrived at the second decimal place.

### ELIGIBILITY FOR ADMISSION

Candidates for admission to the M.Sc.(Hort.) program should satisfy the following requirements.

Candidates seeking admission to the M.Sc. (Ag./Hort.) Degree program should have completed any one of the following **four year degree programs** viz., B.Sc. (Hons.) Agriculture/B.Sc.(Hons.) Horticulture/B.Sc.(Hort.)/B.Tech.(Hort.)/B.Sc. (Ag.)/B.Tech.(Agri. Bio-tech.) from any recognised university.

Candidates who have undergone the program under conventional system should possess not less than a second class Bachelor’s degree. For those under 10 point system a minimum OGPA of 6.00 out of 10.00 and 6.50 out of 10.00 in the subject concerned is required. However, this will not apply to SC/ST candidates for whom a pass in the degree concerned is sufficient.

A common entrance test will be held for all the MSc (Horticulture) degree programs. Candidates shall be based on the rankings in the said entrance examinations.

## DURATION

The duration for the M.Sc. (Horticulture) program will be of two years with four semesters. A student registered for M.Sc. (Horticulture) program should complete the course within four years from the date of his/her admission.

## Credit Grade Point Requirements

A student enrolled for the Master's degree program to earn eligibility for the degree is required to complete 72 credits as detailed below:

Major Subjects	24
Minor Subjects	06
Compulsory	14
Supporting subjects	09
Seminar	01
Research	18
<b>Total Credits</b>	<b>72</b>

**Minor Courses:** Minor courses are to be chosen by the students from the **related** discipline either from other specialization/or from other departments in consultation with the Chairman based on their research specialization.

## Minimum Grade Point Requirements

A post graduate student should maintain a minimum Grade Point of 6.50 out of 10 to secure a pass in a subject. In the subjects in whom a student fails, he/she has to reappear for the examination to get a pass in that subject.

## Attendance Requirements

One hundred per cent attendance is expected of each student. A student, who fails to secure a minimum of 70% attendance in each subject separately for theory and practicals, shall not be permitted to appear for the final examination in that subject and will be required to repeat the subject when offered.

In case of new admission, who are permitted to join late due to administrative reasons, the attendance will be calculated from the date of joining of the student. However, for genuine reasons, condonation of attendance deficiency may be considered by the Vice-Chancellor on the recommendation of the Head of the Department and the Dean, School of life sciences on payment of condonation fee prescribed by the University.

## ADVISORY COMMITTEE

Each post-graduate student shall have an Advisory Committee to guide him/her in carrying out the research program. The Advisory Committee shall comprise a Major Adviser (Chairman) and two members. Of the two members, one will be from the same Department and the other in the related field from the other Departments. The Advisory Committee shall be constituted within two months from the date of commencement of the first semester.

## PROGRAM OF STUDY

The student's plan for the post-graduate work, drawn up by the Advisory Committee, shall be finalized before the end of the first semester.

Program of research work: The outline of research work of the student, in the prescribed manner and as approved by the Advisory Committee, shall be forwarded by the Chairman to the Head of the Department concerned by the end of the first semester.

## EVALUATION OF STUDENT PERFORMANCE

### Internal Assessment

Exam/Test	Subjects with Practicals	Subjects without Practicals	Subjects without Theory
INTERNAL	20	40	40
FINAL THEORY	60	60	-
FINAL PRACTICALS	20	-	60
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>

### Final Examinations

#### Theory Examinations Assessment (as with CUTN regulations)

The pattern of practicals part should be uniform across the departments

#### Grading

- The student should secure 60 per cent marks separately in theory and practical and 65 per cent marks in aggregate to secure a pass in the subject. Students who secure marks below 65 per cent in a subject will be treated as reappearance (RA).
- Each subject shall carry a maximum of 100 marks for purpose of grading. The grading shall be done as grade point, i.e., the percentage of marks earned in a subject is divided by ten. The grade point is expressed on a 10 point scale up to two decimals.
- The reappearance examinations for the candidates who fail in a subject or subjects will be held in the subsequent semester.
- Students who did not fulfill the required minimum attendance of 70% will be awarded 'E' grade and has to repeat the subject.

#### Non-Credit Compulsory Subjects

For non-credit compulsory subjects the evaluation processes will be as that of the regular subjects, however, the marks obtained will not be taken into account to calculate the CGPA.

#### Credit Seminar

Seminar is compulsory for all the students and each student should present a seminar of 0+1 credit in the third semester.

The seminar topic should be only from the major field and should not be related to the area of thesis research. The seminar topics are to be assigned to the students by the Chairman of the Advisory Committee in consultation with the Head of the Department concerned within 2 weeks after the commencement of the semester.

Under the guidance and supervision of the Chairman of the Advisory Committee, the student will prepare the seminar paper after reviewing all the available literature and present the seminar 2 weeks after completion of Mid-Semester Examination in the presence of the Head of the Department, Advisory Committee, staff members and PG students.

The Chairman will monitor the progress of the preparation of the seminar paper and correct the manuscript containing not less than 25 typed/printed pages with a minimum number of 50 references covering the recent 10 years. The student will submit 2 copies of the corrected manuscript to the Head of the Department concerned through the Chairman before presentation.



The student will incorporate suggestions and carry out corrections made during the presentation and resubmit three fair copies to the Head of the Department concerned through the Chairman (one copy each to Dept. Library, Chairman and the student) within 10 days after presentation.

The performance of the student has to be evaluated for 100 marks and Grade Point will be awarded by the Head of the Department concerned along with Advisory Committee.

The Grade Point may be given based on the following norms:

Coverage of Literature	40
Presentation	30
Use of Audio–Visual Aids	10
Capacity to Participate in the discussion and answer the Questions	20
<b>Total</b>	<b>100</b>

### **Term Paper/Special Assignment**

This has to be assigned to the student by the teacher in subject with theory and practical. Term papers should cover a wide range of topics within the subject limits. The topic should be different from that of the credit seminar. Term papers / special assignments will be evaluated during practical examination.

### **Comprehensive Qualifying Examination**

Only those students who successfully completed the qualifying examination will be admitted to candidacy of the degree. The qualifying examination consists of written and oral examination.

### **Minimum Requirement for Qualifying Examination**

The students who have passed major courses will be permitted to appear for the qualifying examination. The qualifying examination will be conducted before the end of the III<sup>rd</sup> semester.

### **Selection of Examiner**

A panel of five external examiners for qualifying examinations shall be given by the HOD at the end of II semester to the Controller of Examinations, who will nominate as per need from the panel of the examiner.

### **Written Examination**

The written examination consists of one paper covering major subjects only. The Controller of Examination will conduct the examination by getting the question paper from external. The external examiner will evaluate the answer papers during his visit to conduct the viva-voce examination.

The question paper for the written examination will be of 3 hours duration and each question (Essay type) need not be restricted to any particular topic in a course but it should be comprehensive. The written examination will be conducted at the same time in all discipline. Qualifying marks for passing the written examination will be 60.

### **Comprehensive Qualifying Viva-Voce Examination**

The advisory committee shall conduct the qualifying viva-voce examination with the external member, who shall be a specialist in the subject from outside the university.

The Heads of departments will monitor and coordinate the conduct of the qualifying viva. The performance of the candidate will be graded as **Satisfactory/Unsatisfactory**.

### **Failure/Absence in Qualifying Examination**

When a student fails or absents for the qualifying examination, he/she may apply again for permission to appear for re-examination to the Head of the Department. A student, who apply for re-examination should attend written examination and viva-voce. Re-examination shall not take place earlier than three months after the first examination and it will be conducted by the advisory committee as previously indicated. If a student fails in the

re-examination, further re-examination will be considered on the recommendation of the Advisory Committee, HOD and Dean. If the students fail in the qualifying examination, the research credits registered in the III semester should not be evaluated unless he / she successfully completes the qualifying examination.

### **Absence of Advisory Committee Member during Qualifying/Final Viva Voce Examination**

Conducting qualifying and final viva voce examination in the absence of advisory committee members is not allowed.

Under extra-ordinary circumstances if the qualifying/final viva-voce examination to postgraduate student has to be conducted in the absence of one or two advisory committee members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Dean in advance through the Head of the Department. The Chairman of the advisory committee in consultation with the concerned member and Head of the Department will co-opt another member.

The co-opted member should be from the same department of the member who is not attending the examinations.

In the absence of the Chairman of advisory committee, respective Heads of Departments should act as Co-chairman with prior permission of Dean.

### **Research Work**

The topic of thesis research to be carried out by the student will be assigned by the Chairman of the Advisory Committee in consultation with the Head/ Chairman of the DRC of the Department concerned. After assigning the topic, each student may be instructed to submit a detailed program of work to be carried out by him/her during the semester in the prescribed proforma. After scrutiny and approval, a copy of the program may be given to the student for carrying out the work during the semester in the prescribed proforma. The evaluation of research work done by the student should be based on the approved program.

### **Evaluation of Dissertation Work**

Attendance register must be maintained in the department by HOD /chairman for all the students to monitor whether the student has 70% of attendance in research.

The student has to submit his/her research observation note book to the major Adviser. The major Adviser will scrutinize the progress and sign the note book with remarks as frequently as possible. This note book will form the basis for evaluation of research progress.

After completion of 70% attendance for research and on or before the last day of the semester, the advisory committee should evaluate the progress of research work as per the approved programme and monitoring register and award **SATISFACTORY OR UNSATISFACTORY** depending upon quantity and quality of work done by the student during the semester.

The procedure of evaluating research credits under different situations are explained hereunder.

#### **Situation-I**

The students has completed the research credits as per the approved program and awarded '**SATISFACTORY**' by the advisory committee. Under the said situation the student can be permitted to register fresh credits in the subsequent semester. If the student is awarded '**UNSATISFACTORY**' he/she has to register afresh the same block of the research credits in the subsequent semester.

#### **Situation-II**

The student who does not satisfy the required **70 per cent** attendance shall be awarded grade 'E'.

### **Situation-III**

The student who could not complete the research work as per the approved programme of work for reasons beyond his/her control such as

- Failure of crop
- Non-Incidence of pests or diseases or lack of such experimental conditions
- Non-availability of treatment materials like planting materials chemicals etc.
- Any other impeding/ unfavourable situation for satisfying the advisory committee
- Under the situations (II&III) grade 'E' should be awarded. The student has to re-register the same block of research credits for which 'E' grade was awarded in the following semester. The student should not be allowed to register for fresh (first time) research credits.
- In the mark sheet, it should be mentioned that 'E' grade was awarded due to lack of attendance or want for favourable conditions.

### **Situation-IV**

The student who fails to complete the research work after repeating the registration for the second time will be awarded '**Unsatisfactory**' and in the mark sheet the 'second time' should be mentioned.

- For the registration of research credits for the third time permission has to be obtained from the Dean of the Faculty and permission for further registration for the fourth time has to be obtained from the University.
- Re-registration of further research credits shall be decided by the University based on the recommendation of the Advisory Committee, Head of the Department concerned and the Dean, Faculty of Agriculture.

### **Situation-V**

- If a student could not complete qualifying examination till the end of the final semester/grace period, 'E' grade should be awarded for the final block of the research credits registered in the final semester. He/She has to re-register the same block of research credits in the next semester and attend the qualifying examination when conducted by the Controller of Examinations.

## **Submission of Dissertation**

The thesis for his/her Master's degree should be of such a nature as to indicate a student's potentialities for conduct of independent research. The thesis shall be on topic falling within the field of the major subject and shall be the result of the student's own work. A certificate to this effect duly endorsed by the Major Adviser (Chairman) shall accompany the thesis.

The research credits registered in the last semester of post graduate programs should be evaluated only at the time of the submission of thesis, by the advisory committee. Students can submit the thesis at the end of the final semester. If a post graduate student has completed the thesis before the closure of the final semester, the chairman can convene the advisory committee meeting and take decision on the submission of thesis provided the student satisfies 80% attendance requirement. Two copies of the thesis should be submitted in paper pack for evaluation to the HOD.

## **Grace Period**

Students can avail a grace period up to a month for submission of thesis/project report after the closure of final semester by paying necessary fine as prescribed by the University. If a student is not able to submit the thesis within a month grace period, the student has to re-register the credits in the forthcoming semester. The student (s) who re-register the credits after availing the grace period will not be permitted to avail grace period.

Based on the recommendation of advisory committee and the Head of the Department, the Dean, can sanction the grace period. A copy of the permission letter along with the receipt for payment of fine as prescribed by the University should accompany the thesis while submission.



## **Submission of Dissertation after Re-registration**

The minimum of 70% attendance requirement for submitting the thesis after, re-registration need not be insisted for those students who have fulfilled the minimum academic and residential requirement i.e. 2 years (4 semesters) and completed the minimum credit requirements for getting degree.

## **Submission of Dissertation**

The thesis submitted in partial fulfillment of a Master's degree shall be evaluated by an external examiner. The external examiner shall be a specialist in the student's major field of study from outside CUTN and shall be appointed by the University as per the recommendation of the Head of the Department.

The external examiner will send the evaluation report in duplicate one marked to the Controller of Examination and another to the Head of the Department along with the corrected copy of the thesis. If the report is favorable, Viva-Voce will be arranged by the Head of the Department concerned and conducted by the Advisory Committee. The chairman of the advisory committee shall send the recommendations of the examining committee to the Controller of Examinations through Head of the Department after the student duly carries out the corrections/ suggestions mentioned by the external examiner (a certificate to be enclosed along with the recommendation). On the unanimous recommendation of the committee and with the approval of the University, the degree shall be awarded to the candidate.

In case of rejection of the thesis by the external examiner, the Controller of Examinations may on the recommendation of the Head of the Department concerned and Advisory Committee refer the thesis for valuation by a second external examiner chosen by the University. If the second external examiner recommends the thesis for acceptance, Viva-Voce will be conducted.

If the revision of the thesis is recommended for repeating experiments, field trial etc., resubmission must be done by the candidate concerned after a minimum of six months. The revised version should be sent to the examiner who recommended revision.

After incorporating the suggestions of the examiners and those received at the time of viva-voce, two hard bound copies of thesis should be submitted to the Department (one to the scholar and one to the chairperson) and two soft copies in CDs to the University. At the time of final submission, the advisory committee members should certify the corrections and suggestions carried out as indicated by the examiners. However, fellowship holder has to submit a hard bound copy also as per the need, 3 copies of abstract of thesis (in 10-15 lines), 2 copies of the summary of the findings both in Tamil and English and also in C.D. form.

## **Revision of Dissertation**

If an examiner recommends for revision of thesis the following norms will be adopted.

For revision of draft, the thesis should be resubmitted after a minimum of one month from the date of communication from the controller of examination.

At the time of submission, the advisory committee should give certificate for carrying out the corrections/recommendations. The resubmitted copies of thesis should be got corrected carrying out the necessary corrections indicated by the external examiner and necessary certificates obtained from the chairman and HOD before the conduct of the final viva-voce.

A fine prescribed by the University to be collected from the students at the time of resubmission of thesis.

## **Failure to Appear for Final Viva Voce/Non-Submission of Dissertation after Viva Voce**

If a candidate fails to appear before the examining committee for final viva-voce, on the date fixed by the HOD the following are the time frame and penalty.

The re-viva-voce must be completed within two years. An amount of fine prescribed by the University must be charged to the candidate.

After successful completion of thesis final viva-voce if a student fails to submit the corrected version of the thesis within 15 days he/she will be levied a fine prescribed by the University at the time of sending the proposal for result declaration.

### **Result Notification**

After the completion of each semester, the student will be given the statement of marks by the Controller of Examinations.

The transcript will be prepared by controller of examinations. The various subjects taken by a student along with the credits and the grade obtained shall be shown on his transcript. Based on the total credits admitted, the final Grade Point Average shall be calculated and given.

### **Award of Medals**

Medal should be awarded only if the student secures at least 8.0 OGPA, clears all courses in first attempt and in the program having a batch of at least three students.

## MSc HORTICULTURE (FRUIT SCIENCE)

SM	CODE	SUBJECT TITLE	CREDITS
01	<b>HOR511</b>	Growth & Development of Horticultural Crops*	2+0
	<b>HOR512</b>	Basic Statistical Methods in Agricultural Research <sup>(s)</sup>	2+1
	<b>HOR513</b>	Biodiversity & Conservation of Horticultural Crops*	2+1
	<b>HOR514</b>	Biotechnology of Horticultural Crops*	2+1
	<b>HOR515</b>	Organic Horticulture*	2+1
	<b>HOR516</b>	Propagation & Nursery Management in Horticultural Crops <sup>(m)</sup>	2+1
	<b>HFS517</b>	Research-I (Synopsis Seminar)	1+0
	<b>TOTAL</b>		<b>13+5=18</b>
02	<b>HOR521</b>	Protected Cultivation of Horticultural Crops*	2+1
	<b>HOR522</b>	Post-Harvest Technology of Horticultural Crops <sup>(m)</sup>	2+1
	<b>HFS523</b>	Tropical & Dryland Fruit Production <sup>(m)</sup>	2+1
	<b>HFS524</b>	Breeding of Fruit Crops <sup>(m)</sup>	2+1
	<b>HFS525</b>	Canopy Management in Fruit Crops <sup>(m)</sup>	2+1
	<b>HOR526</b>	Research-II & Seminar	2+1
	<b>TOTAL</b>		<b>12+6=18</b>
03	<b>HOR611</b>	Library, Information and Technical Writing <sup>(s)</sup>	2+1
	<b>HOR612</b>	<i>Elective Courses from Other Cognate Departments<sup>(mi)</sup></i>	2+1
	<b>HOR613</b>	Intellectual Properties Rights & Its Management in Agriculture <sup>(mi)</sup>	2+1
	<b>HFS614</b>	Sub-Tropical & Temperate Fruit Production <sup>(m)</sup>	2+1
	<b>HFS615</b>	Minor & Underutilized Fruit Crops <sup>(m)</sup>	2+1
	<b>HFS616</b>	Research III	3+0
	<b>TOTAL</b>		<b>13+5=18</b>
04	<b>HOR621</b>	<i>Elective Course for Other Specialization (from Vegetables or Floriculture)<sup>(mi)</sup></i>	3+1
	<b>HFS622</b>	Plant Production & Breeding of Plantation Crops <sup>(m)</sup>	2+1
	<b>HFS623</b>	Research IV (Data Analysis & Interpretation)	6+0
	<b>HFS624</b>	Research V (Dissertation Viva)	6+0
	<b>HFS625</b>	Comprehensive Exam Qualifying Viva (Non-Credit Compulsory)	NC
	<b>TOTAL</b>		<b>17+1=18</b>

\*-Compulsory course, (m) - Major Course, (s) - Supporting course, (mi) - minor

## MSc HORTICULTURE (VEGETABLE SCIENCE)

SM	CODE	SUBJECT TITLE	CREDITS
01	<b>HOR511</b>	Growth & Development of Horticultural Crops*	2+0
	<b>HOR512</b>	Basic Statistical Methods in Agricultural Research <sup>(s)</sup>	2+1
	<b>HOR513</b>	Biodiversity & Conservation of Horticultural Crops*	2+1
	<b>HOR514</b>	Biotechnology of Horticultural Crops*	2+1
	<b>HOR515</b>	Organic Horticulture*	2+1
	<b>HOR516</b>	Propagation & Nursery Management in Horticultural Crops <sup>(m)</sup>	2+1
	<b>HVS517</b>	Research-I (Synopsis Seminar)	1+0
	<b>TOTAL</b>		<b>13+5=18</b>
02	<b>HOR521</b>	Protected Cultivation of Horticultural Crops*	2+1
	<b>HOR522</b>	Post-Harvest Technology of Horticultural Crops <sup>(m)</sup>	2+1
	<b>HVS523</b>	Production Technology of Warm Season Vegetable Crops <sup>(m)</sup>	2+1
	<b>HVS524</b>	Breeding of Vegetable Crops <sup>(m)</sup>	2+1
	<b>HVS525</b>	Seed Production Technology of Vegetable Crops <sup>(m)</sup>	2+1
	<b>HVS526</b>	Research-II & Seminar	2+1
	<b>TOTAL</b>		<b>12+6=18</b>
03	<b>HOR611</b>	Library, Information and Technical Writing <sup>(s)</sup>	2+1
	<b>HOR612</b>	<i>Elective Courses from Other Cognate Departments<sup>(mi)</sup></i>	2+1
	<b>HOR613</b>	Intellectual Properties Rights & Its Management in Agriculture <sup>(mi)</sup>	2+1
	<b>HVS614</b>	Production Technology of Cool Season Vegetables <sup>(m)</sup>	2+1
	<b>HFS615</b>	Minor & Underutilized Fruit Crops <sup>(m)</sup>	2+1
	<b>HVS616</b>	Research III	3+0
	<b>TOTAL</b>		<b>13+5=18</b>
04	<b>HOR621</b>	<i>Elective Course for Other Specialization (from Fruit Science or Floriculture)<sup>(mi)</sup></i>	3+1
	<b>HVS622</b>	Plant Production & Breeding of Spices <sup>(m)</sup>	2+1
	<b>HVS623</b>	Research IV (Data Analysis & Interpretation)	6+0
	<b>HVS624</b>	Research V (Dissertation & Viva)	6+0
	<b>HVS625</b>	Comprehensive Exam Qualifying Viva (Non-Credit Compulsory)	NC
	<b>TOTAL</b>		<b>17+1=18</b>

\*-Compulsory course, (m) - Major Course, (s) - Supporting course, (mi) - minor

## MSc HORTICULTURE (FLORICULTURE & LANDSCAPING SCIENCE)

SM	CODE	SUBJECT TITLE	CREDITS
01	<b>HOR511</b>	Growth & Development of Horticultural Crops*	2+0
	<b>HOR512</b>	Basic Statistical Methods in Agricultural Research <sup>(s)</sup>	2+1
	<b>HOR513</b>	Biodiversity & Conservation of Horticultural Crops*	2+1
	<b>HOR514</b>	Biotechnology of Horticultural Crops*	2+1
	<b>HOR515</b>	Organic Horticulture*	2+1
	<b>HOR516</b>	Propagation & Nursery Management in Horticultural Crops <sup>(m)</sup>	2+1
	<b>HFL517</b>	Research-I (Synopsis Seminar)	1+0
	<b>TOTAL</b>		<b>13+5=18</b>
02	<b>HOR521</b>	Protected Cultivation of Horticultural Crops*	2+1
	<b>HOR522</b>	Post-Harvest Technology of Horticultural Crops <sup>(m)</sup>	2+1
	<b>HFL523</b>	Production Technology of Loose Flowers <sup>(m)</sup>	2+1
	<b>HFL524</b>	Breeding of Flower Crops & Ornamental Plants <sup>(m)</sup>	2+1
	<b>HFL525</b>	Landscaping & Ornamental Gardening <sup>(m)</sup>	2+1
	<b>HFL526</b>	Research-II & Seminar	2+1
	<b>TOTAL</b>		<b>12+6=18</b>
03	<b>HOR611</b>	Library, Information and Technical Writing <sup>(s)</sup>	2+1
	<b>HOR612</b>	<i>Elective Courses from Other Cognate Departments<sup>(mi)</sup></i>	2+1
	<b>HOR613</b>	Intellectual Properties Rights & Its Management in Agriculture <sup>(mi)</sup>	2+1
	<b>HFL614</b>	Production Technology of Cut Flowers <sup>(m)</sup>	2+1
	<b>HFL615</b>	Turf & Turf Management <sup>(m)</sup>	2+1
	<b>HFL616</b>	Research III	3+0
	<b>TOTAL</b>		<b>13+5=18</b>
04	<b>HOR621</b>	<i>Elective Course for Other Specialization (from Fruit Science or Vegetables)<sup>(mi)</sup></i>	3+1
	<b>HFL622</b>	CAD for Outdoor & Indoor Scaping <sup>(m)</sup>	2+1
	<b>HFL623</b>	Research IV (Data Analysis & Interpretation)	6+0
	<b>HFL624</b>	Research V (Dissertation & Viva)	6+0
	<b>HFL625</b>	Comprehensive Exam Qualifying Viva (Non-Credit Compulsory)	NC
	<b>TOTAL</b>		<b>17+1=18</b>

\*-Compulsory course, (m) - Major Course, (s) - Supporting course, (mi) - minor

# COMPULSORY COURSE CONTENTS

## HOR511 - GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS\*

### THEORY

#### UNIT I

Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis. Environmental impact on growth and development, effect of light, photosynthesis and photoperiodism, vernalisation, effect of temperature, heat units, thermoperiodism.

Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors.

Developmental physiology and biochemistry during dormancy, budbreak, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.

Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

### PRACTICALS

#### UNIT II

Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs, visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns, techniques of growth analysis, evaluation of photosynthetic efficiency under different environments, study of growth regulator functions, hormone assays, understanding ripening phenomenon in fruits and vegetables, study of impact of physical manipulations on growth and development, study of chemical manipulations on growth and development, understanding stress impact on growth and development.

### SUGGESTED READING

1. Buchanan B, Gruissem W & Jones R. 2002. Biochemistry & Molecular Biology of Plants. John Wiley & Sons.
2. Epstein E. 1972. Mineral Nutrition of Plants: Principles and Perspectives.
3. Wiley. Fosket DE. 1994. Plant Growth and Development: a Molecular Approach. Academic Press.
4. Leopold AC & Kriedemann PE. 1985. Plant Growth and Development. 3<sup>rd</sup> Ed. McGraw-Hill.
5. Peter KV. 2008. (Ed.) Basics of Horticulture. New India Publ. Agency.
6. Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: Plants (I. Ridge, Ed.), pp. 221-274, Oxford University Press.
7. Salisbury FB & Ross CW. 1992. Plant Physiology. 4<sup>th</sup> Ed. Wadsworth Publ.
8. Nutritional disorders in fruit crops diagnosis and management by M. Prakash, K. Belakrishnan, A. Rathinasamy. New India Publishing Agency
9. Fruits of warm climate (Julia F. Morton). Published by Echo Point Books and Media, 2013  
Introduction to fruit crop by Mark Rieger. Published by Taylor and Francis, 2006
10. Pest of fruit crops (a colour Handbook) 2<sup>nd</sup> edition by David. V. Alford. Published by CRC press, 2016



11. Tropical fruit tree diversity (good Practices for in-situ an on-farm conservation) edited by Bhuwan Shapit, Hugo. A. H. Lamers, V. Ramanatha Rao and Arwein Bailey. First published by Routledge, 2Park Square, Milton Park, Abingdon, Oxon OX14 4RN and By Routledge 711<sup>TH</sup> Avenue , New York, NY 10017
12. Temperate horticulture (Current Scenario) By D.K. Kishori, Satish K. Sharma, K.K. Pramanish. New India Publishing Agency

## **HOR513 - BIODIVERSITY AND CONSERVATION OF HORTICULTURAL CROPS\***

### **THEORY**

#### **UNIT I**

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity. Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ*.

#### **UNIT II**

Germplasm conservation-problem of recalcitrancy-cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

GIS and documentation of local biodiversity, Geographical indication.

Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus, *Prunus* sp., litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

### **PRACTICALS**

#### **UNIT III**

Documentation of germplasm-maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation—cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques. Visit of NBPGR, New Delhi and Barapani, Meghalaya.

### **SUGGESTED READING**

1. Peter KV & Abraham Z. 2007. *Biodiversity in Horticultural Crops*. Vol. I. Daya Publ. House.
2. Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow*. Cambridge University Press.
3. Peter KV. 2008. *Biodiversity of Horticultural Crops*. Vol. II. Daya Publ. House.
4. Tropical fruit tree diversity (good Practices for in-situ and on-farm conservation) edited by Bhuwan Shapit, Hugo. A. H. Lamers, V. Ramanatha Rao and Arwein Bailey. First published by Routledge, 2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN and By Routledge 711rd Avenue, New York, NY 10017

## HOR514 - BIOTECHNOLOGY OF HORTICULTURAL CROPS\*

### THEORY

#### UNIT I

Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.

Use of bioreactors and in vitro methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants.

Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - in vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.

#### UNIT II

Physiology of hardening - hardening and field transfer, organ culture, meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.

Construction and identification of somatic hybrids and cybrids, wide hybridization, in vitro pollination and fertilization, haploids, in vitro-mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering in horticulture crops, use of molecular markers. In vitro selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

### PRACTICALS

#### UNIT III

An exposure to low cost, commercial and homestead tissue culture laboratories, media preparation, inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus, sub-culturing, techniques on anther, ovule, embryo culture, somaclonal variation, *in vitro* mutant selection against abiotic stress, protoplast culture, fusion technique, development of protocols for mass multiplication, project development for establishment of commercial tissue culture laboratory. Hardening – case studies, micropropagation, explant preparation, media preparation, culturing – in vitro clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, micrografting, hardening.

Visit of Biotech lab at IARI, New Delhi, HAFRP, Ranchi and private companies at Pune, Bengaluru.

### SUGGESTED READING

1. Bajaj YPS. (Ed.).1989. Biotechnology in Agriculture and Forestry. Vol. V, Fruits. Springer.
2. Brown TA. 2001. Gene Cloning and DNA Analysis and Introduction. Blackwell Publ.
3. Chopra VL & Nasim A. 1990. Genetic Engineering and Biotechnology – Concepts, Methods and Applications. Oxford & IBH.
4. Gordon H & Rubsall S. 1960. Hormones and Cell Culture. AB Book Publ.
5. Keshavachandran R & Peter KV. 2008. Plant Biotechnology: Tissue Culture and Gene Transfer. Orient & Longman (Universal Press).
6. Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. 2007. Recent Trends in Biotechnology of Horticultural Crops. Vols. I, II. New India Publ. Agency.

7. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. Biotechnology of Horticultural Crops. Vols. I-III. NayaProkash.
8. Pierik RLM. 1987. In vitro Culture of Higher Plants. MartinusNijhoff Publ.
9. Skoog F & Miller CO. 1957. Chemical Regulation of Growth and Formation in Plant Tissue Culture *in vitro*. Symp. Soc. Exp. Biol. 11: 118-131
10. Vasil TK, Vasi M, White DNR & Bery HR. 1979. Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture. Plenum Press.
11. Williamson R. 1981-86. Genetic Engineering. Vols. I-V. Academic Press.
12. Genetic Engineering of Horticultural Crops 1st Edition. Gyana Rout KV Peter. Elsevier (2018)
13. Biotechnology in Horticulture: Methods and Applications. Peter, K.V. New India Publishing Agency (2013)
14. Transgenic Horticultural Crops. ScorzaMouScorzaMou. Productivity PrInc (2011).

## **HOR515 - ORGANIC HORTICULTURE\***

### **THEORY**

#### **UNIT I**

Organic horticulture – definition, synonyms and misnomers, principles, methods, merits and demerits.

Organic farming systems, components of organic horticultural systems, different organic inputs, their role in organic horticulture, role of biofertilizers, biodynamics and the recent developments.

Bioformulation-Panchagavya, amritpani, jeevamruth, beejamruth: its preparation and uses.

EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement.

#### **UNIT II**

GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.

Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, post-harvest management of organic produce.

### **PRACTICALS**

#### **UNIT III**

Features of organic orchards, working out conversion plan, Input analysis-manures, nutrient status assessment of manures, biocomposting, biofertilizers and their application, panchagavya preparation and other organic nutrients application, methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application, BD preparations and their role, EM technology and products, biological/natural control of pests and diseases, soil solarization, framework for GAP, case studies, HACCP analysis, residue analysis in organic products, documentation for certification, visit to fields cultivated under organic practices.

Visit of quality control lab at YSPUH&F, Solan, IARI, New Delhi.

### **SUGGESTED READING**

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

## HOR521 - PROTECTED CULTIVATION OF HORTICULTURAL CROPS\*

### THEORY

#### UNIT I

Greenhouse – World scenario, Indian situation: present and future. Basics of greenhouse design, different types of structures – glasshouse, shade net, poly tunnels - Design and development of low cost greenhouse structures.

#### UNIT II

Protected cultivation of Strawberry, Capsicum, Tomato, Cucumber, Melon, Lettuce, Rose, Carnation, Anthurium, Lilium and Gerbera.

Precision farming, principles and concepts, enabling technologies of precision farming, GPS, CIS, Remote sensing.

### PRACTICALS

#### UNIT III

Designs of greenhouse, low cost poly tunnels, nethouse- Regulation of light, temperature, humidity in greenhouses, media, greenhouse cooling systems, ventilation systems, fertigation systems, special management practices, project preparation for greenhouses, visit to greenhouses. Visit of protected structure at UAS, Dharwad, NAU, Navsari, DFR, Pune, IARI, New Delhi, IIHR, Bengaluru.

### SUGGESTED READING

1. Aldrich RA & Bartok JW. 1994. *Green House Engineering*. NRAES, Riley, Robb Hall, Cornell University, Ithaca, New York.
2. Bhattacharjee BS. 1959. *Rose Growing in Tropics*. Thackarspink & Co.
3. Laurie A, Kipling DD & Nelson KS. 1968. *Commercial Flower Forcing*. McGraw-Hill.
4. Mears DR, Kim MK & Roberts WJ. 1971. *Structural Analysis at an Experimental Cable-supported Air Inflated Green Houses*. Trans. ASAE.
5. Pant V Nelson. 1991. *Green House Operation and Management*. Bali Publ.
6. Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2007. *Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.
7. Singh, B. 2017. *Advances in Protected Cultivation*, NIPA, New Delhi
8. Gurugnanam, B. 2015. *Geographic Information System*, NIPA, New Delhi
9. Singh, J. 2016. *Precision Farming in Horticulture*, NIPA, New Delhi
10. Kumar, D. V. and Peter, K.V. 2014. *Protected Cultivation of Horticultural crops*, NIPA, New Delhi



## MAJOR COURSE CONTENTS

### HOR516 - PROPAGATION AND NURSERY MANAGEMENT IN HORTICULTURAL CROPS<sup>(m)</sup>

#### THEORY

##### UNIT I

Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth. Seed quality, treatment, packing, storage, certification, testing. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hot beds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

##### UNIT II

Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working – Progeny orchard and scion bank. Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

Nursery and plant protection application during nursery. Nursery registration Act. Hardening plants in the nursery. Maintenance of nursery records.

#### PRACTICALS

##### UNIT III

Anatomical studies in rooting of cutting and graft union, construction of propagation structures, study of media and PGR.

Visit to Tissue Culture labs of ICAR Institutes, NRC on citrus, Nagpur and government approved/private nurseries.

#### SUGGESTED READING

1. Hartmann HT & Kester DE. 1989. Plant Propagation – Principles and Practices. Prentice Hall of India.
2. Bose TK, Mitra SK & Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops. NayaProkash.
3. Peter KV. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency.
4. Singh SP. 1989 Mist Propagation. Metropolitan Book Co.
5. Rajan S & Baby LM. 2007. Propagation of Horticultural Crops. New India Publ. Agency.
6. Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.
7. Tropical fruits volume 1, 2 (Robert E. Paull and OdiloDaurte) copyright by CAB international.
8. Temperate horticulture (Current scenario) By D.K. Kishori, Satish K. Sharma, K.K. Pramanish. New India Publishing Agency

## HOR522 – POST-HARVEST TECHNOLOGY OF HORTICULTURAL CROPS(m)

### THEORY

#### UNIT I

Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration.

Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage- ventilated, refrigerated, MA, CA storage, physical injuries and disorders. Role of Vitamins.

#### UNIT II

Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards. Extruder Technology.

### PRACTICALS

#### UNIT III

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cutflower using chemicals, estimation of quality characteristics in stored fruits and vegetables, cold chain management- visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products. Processing of sauces, ketchup, beverages. Analysis of curcumin. Visit to ICAR institutes like CISH, Lucknow, IARI, New Delhi, private companies at Sikkim, Tripura, Nagaon, Guwahati, IIHR, Bengaluru.

### SUGGESTED READING

1. Bhutani RC. 2003. *Fruit and Vegetable Preservation*. Biotech Books. & Pareek OP.(Eds.).1996 *Advances in Horticulture*. Vol.IV. Malhotra Publ. House.
2. Haid NF & Salunkhe SK. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ.
3. Mitra SK.1997.*Post Harvest Physiology and Storage Sub-tropical Fruits*. CABI.
4. Ranganna S.1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.
5. Sudheer KP & IndiraV.2007.*Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.
6. Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. *Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.
7. Tripathi, M. K. and Mangaraj, S. (2013) *Advances in Food Processing Technology*. Ed. 2013(1st). Pub: Narendra Publishing House, 1417, Kishan Dutt Street, Maliwara, Delhi-110006. Rashtriya Printers Delhi, India.
8. Sharma, S. K. and Nautiyal, M. C. (2009) *Postharvest Technology of Horticultural Crop*, Pub: New India Publishing Agency, 101 Vikas Surya Plaza, CU Block, L.S.C. mkt, Pitampuram, New Delhi-110088. Jai Bharat Printing Press Delhi, India.

9. Kalia, M. (2006) Postharvest Technology of vegetables, Pub: Agro-tech Publishing Academy, 124, Anand Plaza, University Road, Udaipur-313001SSS. SSS printers New Delhi, India.
10. Gupta, S. (2012) Food Processing and Agro-based Industries, Pub: Engineer India Research Instt. 4499 NaiSarak, Main Road,Chawri Bazar, New Delhi-110006. Swastik Offset Delhi, India
11. Chakraverty, A., Majumdar, A. S., Raghavan, G. S. V. and Ramaswamy, H. S. (2010) Handbook of Postharvest Technology Cereals, Fruits, Vegetables, Tea and Spices, Pub: Marcel Dekker, Inc. 270, Madison Avenue, Newyork- 10016. NutechPhotolithographers, United States of America.

## HFS523 - TROPICAL AND DRY LAND FRUIT PRODUCTION(m)

### THEORY

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bio regulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.

### UNIT I

Mango, Banana, Citrus, Papaya, Guava, Sapota, Jackfruit, Pineapple.

### UNIT II

Annonas, Avocado Aonla, **Blood Fruit**, Phalsa and Ber, minor fruits of tropics

### PRACTICALS

#### UNIT III

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, Project preparation for establishing commercial orchards. Visit of ICAR institute like IHR, Bengaluru, TNAU, Coimbatore, CRIDA, CIAH, Bikaner, NRC on Citrus, Nagpur, CISH, Lucknow, SAUs like MPUAT, Udaipur, NDUAT, Faizabad, UP.

### SUGGESTED READING

1. Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits- Horticulture*. Allied Publ. Bose TK, Mitra SK & Sanyal D. 2001. (Eds.). *Fruits -Tropical and Subtropical*. Naya Udyog.
2. Chadha KL & Pareek OP.1996.(Eds.).*Advances in Horticulture*.Vols. II- IV. Malhotra Publ. House. Nakasone HY & Paul RE. 1998. *Tropical Fruits*. CABI.
3. PeterKV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency. Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*.PartsI, II. New India Publ. Agency.
4. RadhaT & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
5. Singh HP, Negi JP &Samuel JC. (Eds.). 2002. *Approaches for Sustainable Development of Horticulture*. National Horticultural Board.
6. Singh HP, Singh G, Samuel JC & Pathak RK. (Eds.).2003.*Precision Farming in Horticulture*. NCPAH, DAC/PFDC, CISH, Lucknow.
7. Tropical fruits volume 1, 2 (Robert E. Paull and OdiloDaurte) copyright by CAB international.
8. Nutritional composition of fruit cultivars edited by Monique S., J. Simmonds and Victor P. Preedy. By Elsevier Academic Press, 2015 (OCOLC) 913923278.
9. Bioactives in fruit (Health benefits and functional food) Margot Skinner and Denise Hunter published by Wiley Backwell.
10. Nutritional disorders in fruit crops diagnosis and management by M. Prakash, K. Belakrishnan, A. Rathinasamy. New India Publishing Agency
11. Fruits of warm climate (Julia F. Morton). Published by Echo Point Books and Media, 2013
12. Introduction to fruit crop by Mark Rieger. Published by Taylor and Francis, 2006
13. Pest of fruit crops (A Colour Handbook) 2<sup>nd</sup> edition by David. V. Alford. Published by CRC press, 2016

## HFS524 - BREEDING OF FRUIT CROPS<sup>(m)</sup>

### THEORY

Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.

### UNIT I

Mango, banana, pineapple, Citrus, grapes, guava, sapota, Jackfruit, papaya, custard apple, Aonla, avocado, ber, Mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam, nuts, Apple, pear, plums, peach, apricot, cherries and strawberry

### PRACTICALS

#### UNIT II

Characterization of germplasm, blossom biology, study of anthesis, estimating fertility status, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for resistance, developing breeding programme for specific traits, visit to research stations working on tropical, sub-tropical and temperate fruit improvement.

### SUGGESTED READING

1. Bose TK, Mitra SK & Sanyal D. (Eds.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3<sup>rd</sup> Ed. Vols. I, II. Naya Udyog.
2. Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.
3. Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.
4. Janick J & Moore JN. 1996. *Fruit Breeding*. Vols. I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.
5. Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
6. Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagminder Book Agency.
7. Tropical fruits volume 1, 2 (Robert E. Paull and Odilo Daurte) copyright by CAB international.
8. Temperate fruit crop breeding (Germplasm to Genomic) by James F. Hancock. Copyright by Springer.

## HFS 525 - CANOPY MANAGEMENT IN FRUIT CROPS<sup>(m)</sup>

### THEORY

#### UNIT I

Canopy management - importance and advantages; factors affecting canopy development.

Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies. Canopy architecture management for precision farming in fruits.

#### UNIT II

Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion.

Canopy management through plant growth inhibitors, training and pruning and management practices.

Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passion fruits, mango, sapota, guava, citrus and ber.

### PRACTICALS

#### UNIT III

Study of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors, geometry of planting; study on effect of different canopy types on production and quality of fruits.

### SUGGESTED READING

1. Chadha KL & Shikhamany SD. 1999. The Grape, Improvement, Production and Post-Harvest Management. Malhotra Publ. House.
2. Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008.
3. Management of Horticultural Crops. New India Publ. Agency
4. Tropical fruits volume 1, 2 (Robert E. Paull and OdiloDaurte) copyright by CAB international.
5. Fruits of warm climate (Julia F. Morton). Published by Echo Point Books and Media, 2013
6. Introduction to fruit crop by Mark Rieger. Published by Taylor and Francis, 2006
7. Tropical fruit tree diversity (good Practices for in-situ an on-farm conservation) edited by Bhuwan Shlapit, Hugo. A. H. Lamers, V. Ramanatha Rao and Arwein Bailey. First published by Routledge, 2Park Square, Milton Park, Abingdon, Oxon OX14 4RN and By Routledge 711rd Avenue , New York, NY 10017
8. Temperate horticulture (Current scenario) By D.K. Kishori, Satish K. Sharma, K.K. Pramanish. New India Publishing Agency.



## HFS614 – SUB-TROPICAL AND TEMPERATE FRUIT PRODUCTION<sup>(m)</sup>

### THEORY

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, AgriExport Zones(AEZ) and industrial support.

### UNIT I

Apple, pear, quince, grapes, Plums, peach, apricot, cherries, Litchi

### UNIT II

Loquat, persimmon, kiwifruit, strawberry, Nuts- walnut, almond, pistachio, pecan, hazelnut.

### UNIT III

Minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate.

### PRACTICALS

#### UNIT IV

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, Project preparation for establishing commercial orchards. Visit of ICAR institutes like CITH, Srinagar, IHBT, Palampur, YSPUH&T, Solan, HP.

### SUGGESTED READING

1. Bose TK, Mitra SK & Sanyal D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3<sup>rd</sup> Ed. Vols. I, II. Naya Udyog.
2. Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I.
  - i. Malhotra Publ. House.
3. Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.
4. Janick J & Moore JN. 1996. *Fruit Breeding*. Vols. I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.
5. Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
6. Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.
7. Tropical fruits volume 1, 2 (Robert E. Paull and Odilo Daurte) copyright by CAB international.
8. Nutritional composition of fruit cultivars edited by Monique S., J. Simmonds and Victor P. Preedy. By Elsevier Academic Press, 2015
9. Temperate fruit crop breeding (Germplasm to Genomic) by James F. Hancock. Copyright by Springer.
10. Bioactives in fruit (Health benefits and functional food) Margot Skinner and Denise Hunter published by Wiley Backwell.
11. Nutritional disorders in fruit crops diagnosis and management by M. Prakash, K. Belakrishnan, A. Rathinasamy. New India Publishing Agency

12. Fruits of warm climate (Julia F. Morton). Published by Echo Point Books and Media, 2013
13. Introduction to fruit crop by Mark Rieger. Published by Taylor and Francis, 2006
14. Pest of fruit crops (A Colour Handbook) 2<sup>nd</sup> edition by David. V. Alford. Published by CRC press, 2016
15. Tropical fruit tree diversity (good Practices for in-situ an on-farm conservation) edited by Bhuwan Slhavit, Hugo. A. H. Lamers, V. Ramanatha Rao and Arwein Bailey. First published by Routledge, 2Park Square, Milton Park, Abingdon, Oxon OX14 4RN and By Routledge 711rd Avenue , New York, NY 10017
16. Temperate horticulture (Current scenario) By D.K. Kishori, Satish K. Sharma, K.K. Pramanish. New India Publishing Agency.

## HFS615 - MINOR AND UNDERUTILIZED FRUIT CROPS(m)

### **THEORY**

Importance, history, origin, area, distribution, botany, taxonomy, varieties and their classification. Climatic and soil requirements, propagation, root stocks and problem of multiplication. Establishment of orchards, planting and aftercare. Nutrition management, nutritional disorders, training, pruning, irrigation, weed control and intercropping. Exploration of production and processing potentials, Physiological disorders causes and remedies, Pest, diseases and their management, Post-harvest handling of the following crops.

Bael, Durian, Rambutan, karonda, woodapple, carambola, breadfruit, Palmyra palm, Manila Tamarind, Lasoda, Langsat, Roseapple, khejri, Marking nut, Hog plum, Mulberry, Phalsa.

### **PRACTICALS**

Study of varieties and species, Propagation methods, Planting and aftercare, Nutrient diagnosis, Study of flowering and fruit set, Identification of pests and diseases and their management. Harvesting and handling. Project preparation for establishment of commercial orchards. Visit to progressive orchards and research centre.

### **SUGGESTED READING**

1. Bose, T.K. and S.K. Mitra (ed). 1990 Tropical and Sub tropical Fruits. Naya Prokash, Calcutta

## **HFS622 - PLANT PRODUCTION AND BREEDING OF PLANTATION CROPS<sup>(m)</sup>**

### **UNIT I**

Role of plantation crops in national economy, area of production, export potential, IPR issues, clean development mechanism, classification and varietal wealth. Cost benefit analysis under organic farming, precision farming for plantation crops, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, processing methods.

### **UNIT II**

Production including temperature, light, humidity and soil pH, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micronutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting for following Crops: Coffee and Tea, Cashew and Cocoa, Rubber

### **UNIT III**

Production including temperature, light, humidity and soil pH, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micronutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting for following Crops: Palmyrah and Oil Palm, Coconut and Arecanut, Wattle and Betel Vine. Important species and cultivars, blossom biology, breeding objectives, approaches for crop improvement, breeding techniques and constraints for the following crops: Coffee and Tea, Cashew and Cocoa, Rubber, Palmyrah and Oil Palm, Coconut and Arecanut, Wattle and Betel Vine.

### **SUGGESTED READING**

1. Chopra VL & Peter KV. 2005. Handbook of Industrial Crops. Panima.
2. Harler CR. 1963. The Culture and Marketing of Tea. Oxford Univ. Press.
3. Kurian A & Peter KV. 2007. Commercial Crops Technology. New India Publ. Agency.
4. Peter KV. 2002. Plantation Crops. National Book Trust.
5. Pradeep Kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. Management of Horticultural Crops. Part I, II. New India Publ. Agency.
6. Rai PS & Vidyachandram B. 1981. Review of Work Done on Cashew. UAS, Research Series No.6, Bangalore.
7. Srivastava HC, Vatsya B & Menon KKG. 1986. Plantation Crops – Opportunities and Constraints. Oxford & IBH.

## HVS523 - PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS<sup>(m)</sup>

### THEORY

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures, economics of crop production and seed production of:

### UNIT I

Tomato, eggplant, hot and sweet peppers, Okra, beans, cowpea and cluster bean

### UNIT II

Cucurbitaceous crops, Tapioca, Sweet potato, Green leafy warm season vegetables

### PRACTICALS

#### UNIT III

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments to demonstrate the role of mineral elements, physiological disorders; plant growth substances and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops. Visit of ICAR institute like IIVR, Varanasi, IARI, New Delhi, CTCRI, Sree Kariyam.

### SUGGESTED READING

1. Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.
2. Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
3. Bose TK, Som MG & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.
4. Brown HD & Hutchison CS. *Vegetable Science*. JB Lippincott Co.
5. Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture*. Vols. A. V-X. Malhotra Publ. House.
6. Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
7. Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons.
8. Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
9. Edmond JB, Musser AM & Andrews FS. 1964. *Fundamentals of Horticulture*. Blakiston Co
10. Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani. Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publ. Agency. Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.
11. Kalloo G & Singh K (Ed.). 2000. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.
12. Nayer NM & More TA 1998. *Cucurbits*. Oxford & IBH Publ. Palaniswamy & Peter KV. 2007. *Tuber Crops*. New India Publ. Agency. Pandey AK & Mudranalay V. (Eds.). *Vegetable Production in India: Important Varieties and Development Techniques*.
13. Rana MK. 2008. *Olericulture in India*. Kalyani.
14. Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani.
15. Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall.

16. SainiGS.2001 .*A Text Book of Oleria and Floriculture*. Aman Publ. House.
17. Salunkhe DK & Kadam SS.(Ed.).1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
18. Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.
19. Singh DK. 2007. *Modern Vegetable Varieties and Production Technology*.International Book Distributing Co.
20. Singh NP, BharadwajAK, Kumar A &Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book DistributingCo.
21. SinghSP.(Ed.).1989.*Production Technology of VegetableCrops*.Agril Comm. Res. Centre.
22. Thamburaj S & Singh N. 2004. *Vegetables, Tuber Crops and Spices*.ICAR.
23. ThompsonHC&KellyWC.(Eds.).1978.*VegetableCrops*.TataMcGraw Hill.
24. Fundamentals of Vegetable Crop Production. Beena,Singh, K.P.,Chand, Prem Nair. Scientific Publishers (2014)
25. Vegetable Crops (Horticulture Science Series). T.R. Gopalakrishnan. New India Publishing Agency (2007)
26. Disease of Vegetable Crops. Shagufta. APH Publishing (2012)

## HVS524 - BREEDING OF VEGETABLE CROPS<sup>(m)</sup>

### THEORY

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act.

### UNIT I

Potato, tomato, Eggplant, hot pepper, sweet pepper and okra, Peas and beans, amaranth, chenopods and lettuce. Gourds, melons, pumpkins and squashes, cabbage, cauliflower, carrot, beetroot, radish, sweet potato and tapioca.

### PRACTICALS

#### UNIT II

Selection of desirable plants from breeding population observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; induction of flowering, palynological studies, selfing and crossing techniques in vegetable crops; hybrid seed production of vegetable crops in bulk. Screening techniques for insect-pests, disease and environmental stress resistance in above mentioned crops, demonstration of sib-mating and mixed population; molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques. Visit to breeding blocks.

### SUGGESTED READING

1. Allard RW. 1999. *Principles of Plant Breeding*. John Wiley & Sons. Basset MJ. (Ed.). 1986. *Breeding Vegetable Crops*. AVI Publ.
2. Dhillon BS, Tyagi RK, Saxena S. & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.
3. Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.
4. Gardner EJ. 1975. *Principles of Genetics*. John Wiley & Sons. Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.
5. Hayward MD, Bosemark NO & Romagosa I. (Eds.). 1993. *Plant Breeding- Principle sand Prospects*. Chapman & Hall.
6. Kalloo G. 1988. *Vegetable Breeding*. Vols. I-III. CRC Press.
7. Kalloo G. 1998. *Vegetable Breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
8. Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.
9. Paroda RS & Kalloo G. (Eds.). 1995. *Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Region*. FAO.
10. Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables*. Revised, ICAR.
11. Rai N & Rai M. 2006. *Heterosis Breeding in Vegetable Crops*. New India Publ. Agency.
12. Ram HH. 1998. *Vegetable Breeding: Principles and Practices*. Kalyani. Simmonds NW. 1978. *Principles of Crop Improvement*. Longman. Singh BD. 1983. *Plant Breeding*. Kalyani.
13. Singh PK, Dasgupta SK & Tripathi SK. 2004. *Hybrid Vegetable Development*. International Book Distributing Co.
14. Swarup V. 1976. *Breeding Procedure for Cross-pollinated Vegetable Crops*. ICAR.
15. Heterosis Breeding in Vegetable Crops. Nagendra Rai and M. K. Rai. New India Publishing Agency (2006)

## HVS 525 - SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS(m)

### THEORY

#### UNIT I

Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India. Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behavior, seed development and maturation; methods of hybrid seed production. Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.

#### UNIT II

Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, colecrops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

### PRACTICALS

#### UNIT III

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; rouging of off-type; methods of hybrid seed production in important vegetable seed extraction techniques; handling of seed processing and seed testing equipment; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms. Visit of ICAR institute like Directorate of Seed Research, Mau, UP, NRC on Seed Spices, Ajmer, IISR, Calicut, NHRDF, Pune.

### SUGGESTED READING

1. Agrawal PK & Dadlani M. (Eds.).1992.*Techniques in Seed Science and Technology*. South Asian Publ.
2. Agrawal RL. (Ed.) 1997.*Seed Technology*. Oxford & IBH.
3. Bendell PE.(Ed.) 1998.*Seed Science and Technology: Indian Forestry Species*. Allied Publ.
4. Fageria MS, Arya PS & Choudhary AK. 2000.*Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.
5. George RAT. 1999. *Vegetable Seed Production*. 2<sup>nd</sup> Ed. CABI.
6. Kumar JC & Dhaliwal MS.1990.*Techniques of Developing Hybrids in VegetableCrops*. Agro Botanical Publ.
7. More TA, Kale PB & Khule BW. 1996. *Vegetable Seed production Technology*. Maharashtra State Seed Corp.
8. Rajan S & Baby L Markose. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.
9. Singh NP, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distributing Co.
10. SinghSP.2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.
11. Vegetable Seed Production. Raymond A. T. George. CABI Publishing; 3rd Edition (2013)
12. Seed Production Technology of Vegetables. Asati B. S and Singh Prabhakar. Daya Publishing House (2008).



## HVS614 - PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLES<sup>(m)</sup>

### THEORY

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

### UNIT I

Potato, Cole crops: cabbage, cauliflower, knolkohl, sprouting broccoli, Brussels sprout

### UNIT II

Root crops: carrot, radish, turnip, Beetroot, Bulb crops: onion and garlic

### UNIT III

Peas and broad bean, green leafy cool season vegetables.

### PRACTICALS

#### UNIT IV

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Experiments to demonstrate the role of mineral elements, plant growth substances and herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/ polyhouse. Visit of CPRI, Shimla, IIVR, Varanasi, IARI, New Delhi.

### SUGGESTED READING

1. Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.
2. Bose TK, Som G & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash. Bose TK, Som MG & Kabir J. (Eds.). 1993. *Vegetable Crops*. Naya Prokash.
3. Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
4. Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture* Vols. V-X. Malhotra Publ. House.
5. Chadha KL. (Ed.). 2002. *Handbook of Horticulture*. ICAR.
6. Chauhan DVS.(Ed.).1986.*Vegetable Production in India*. Ram Prasad & Sons.
7. Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
8. Edmond JB, Musser AM & Andrews FS. 1951. *Fundamentals of Horticulture*. Blakiston Co.
9. Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
10. Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publ. Agency. HazraP&SomMG.(Eds.).1999.*TechnologyforVegetableProductionandImprovement*. Naya Prokash.
11. Rana MK. 2008. *Olericulture in India*. Kalyani Publ.
12. Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani Publ. Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall.
13. Saini GS. 2001. *A Text Book of Oleri and Floriculture*. Aman Publ. House.
14. Salunkhe DK & Kadam SS.(Ed.).1998. *HandBook of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
15. Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford& IBH.
16. SinghDK.2007.*Modern Vegetable Varieties and Production Technology*. International Book Distributing Co.

17. Singh SP.(Ed.).1989.*ProductionTechnologyofVegetableCrops*.Agril.Comm. Res. Centre.
18. Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
19. Thompson HC & Kelly WC.(Eds.).1978.*VegetableCrops*.TataMcGraw- Hill.
20. Fundamentals of Vegetable Crop Production. Beena, Singh, K.P., Chand, Prem Nair. Scientific Publishers (2014)
21. Vegetable Crops (Horticulture Science Series). T.R. Gopalakrishnan. New India Publishing Agency (2007)
22. Disease of Vegetable Crops. Shagufta. APH Publishing (2012).

## HVS622 - PLANT PRODUCTION AND BREEDING OF SPICES<sup>(M)</sup>

### UNIT I

Introduction, importance of spice crops – historical accent, present status- national and international, future prospects.

### UNIT II

Botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, 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, physiological disorders, harvesting, postharvest management, plant protection measures and seed planting material and micro-propagation, precision farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of following crops: Black pepper, Cardamom Clove, Cinnamon and Nutmeg, Allspice, Turmeric, Ginger and Garlic

### UNIT III

Botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, 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, physiological disorders, harvesting, postharvest management, plant protection measures and seed planting material and micro-propagation, precision farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of following crops: Coriander, Fenugreek, Cumin, Fennel, Ajowain, Dill, Celery, Tamarind, Garcinia and Vanilla - Important species and cultivars, blossom biology, breeding objectives, approaches for crop improvement, breeding techniques and constraints for the following crops: Blackpepper, Cardamom, Clove, Cinnamon and Nutmeg, Allspice, Turmeric, Ginger And Garlic, Coriander, Fenugreek, Cumin, Fennel, Ajowain, Dill, Celery, Tamarind, Garcinia and Vanilla

### SUGGESTED READING

1. Agarwal S, Sastry EVD & Sharma RK. 2001. Seed Spices: Production, Quality, Export. Pointer Publ.
2. Arya PS. 2003. Spice Crops of India. Kalyani.
3. Bhattacharjee SK. 2000. Hand Book of Aromatic Plants. Pointer Publ.
4. Kumar NA, Khader P, Rangaswami & Irulappan I. 2000. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford & IBH.
5. Nybe EV, Miniraj N & Peter KV. 2007. Spices. New India Publ. Agency.
6. Parthasarthy VA, Kandiannan V & Srinivasan V. 2008. Organic Spices. New India Publ. Agency.
7. Peter KV. 2001. Hand Book of Herbs and Spices. Vols. I-III. Woodhead Publ. Co. UK and CRC USA

## HFL523 - PRODUCTION TECHNOLOGY OF LOOSE FLOWERS<sup>(m)</sup>

### THEORY

#### UNIT I

Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shade nets, transplanting techniques. Soil and climate requirements, field preparation, systems of planting, precision farming techniques. Water and nutrient management, weed management, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM.

#### UNIT II

Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation.

#### UNIT III

Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packing and storage, value addition, concrete and essential oil extraction, transportation and marketing, export potential, institutional support, Agri Export Zones. Crops: Jasmine, scented rose, chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, lilies, tecoma, champaka, pandanus).

### PRACTICALS

Botanical description of species and varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, storage and cold chain, project preparation for regionally important commercial loose flowers, visits to fields, essential oil extraction units and markets. Visits of IIHR, Bengaluru, TNAU, Coimbatore, KAU, Thrissur, BCKV, Kalyani, AAU, Jorhat.

### SUGGESTED READING

1. Arora JS. 2006. *Introductory Ornamental Horticulture*. Kalyani. Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols.I-VI. Pointer Publ.
2. Bose TK & Yadav LP. 1989. *Commercial Flowers*. Naya Prokash.
3. Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping*. Naya Prokash.
4. Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.
5. Chadha KL. 1995. *Advances in Horticulture*. Vol. XII. Malhotra Publ. House.
6. Lauria A & Ries VH. 2001. *Floriculture—Fundamentals and Practices*. Agrobios.
7. Prasad S & Kumar U. 2003. *Commercial Floriculture*. Agrobios.
8. Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
9. Sheela VL. 2007. *Flowers in Trade*. New India Publ. Agency. Valsala Kumari PK, Rajeevan PK, Sudhadevi PK & Geetha CK. 2008. *Flowering Trees*. New India Publ. Agency.
10. De LC. 2013. *Value Additions in Flowers and Orchids*, Pointer Publ.

## HFL524 - BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS(m)

### THEORY

#### UNIT I

Principles—Evolution of varieties, origin, distribution, genetic resources, genetic divergence- Patents and Plant Variety Protection in India.

Genetic inheritance—of flower colour, doubleness, flower size, fragrance, post harvest life.

Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants-- introduction, selection, domestication, polyploidy and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops.

#### UNIT II

Breeding constraints and achievements made in commercial flowers-rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliums, nerium.

Breeding constraints and achievements made in ornamental plants – petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snapdragon, pansy) and ornamental foliage— Introduction and selection of plants for waterscaping and xeriscaping.

### PRACTICALS

#### UNIT III

Description of botanical features – Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production-Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants. Visit to IARI, New Delhi, YSPUH&T, Solan, HAFRP, Ranchi, PAU, Ludhiana, DFR, Pune.

### SUGGESTED READING

1. Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
2. Bose TK & Yadav LP. 1989. *Commercial Flowers*. Naya Prokash.
3. Chadha KL & Choudhury B. 1992. *Ornamental Horticulture in India*. ICAR.
4. Chadha KL. 1995. *Advances in Horticulture*. Vol. XII. Malhotra Publ House.
5. Chaudhary RC. 1993. *Introduction to Plant Breeding*. Oxford & IBH. Singh BD. 1990. *Plant Breeding*. Kalyani.
6. Singh, A.K. 2015. *Breeding and Biotechnology of Flowers: Set of 2 Vols*. Pointer Publ.

## HFL525 - LANDSCAPING AND ORNAMENTAL GARDENING(m)

### THEORY

#### UNIT I

Landscape designs, types of gardens, History of Landscape Gardening, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens.

Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates.

Garden plant 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, bamboo groves; Production technology for selected ornamental plants.

#### UNIT II

Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves. Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, waterscaping, xeriscaping, hardscaping.

### PRACTICALS

#### UNIT III

Selection of ornamental plants, practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens, Visit of LalBagh, Bengaluru, IARI, New Delhi.

### SUGGESTED READING

1. Bose, T. K, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping*. Naya Prokash.
2. Lauria A & Victor HR. 2001. *Floriculture—Fundamentals and Practices* Agrobios.
3. Nambisan KMP. 1992. *Design Elements of Landscape Gardening*. Oxford & IBH.
4. Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
5. Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.
6. Valsalakumari et al. 2008. *Flowering Trees*. New India Publ. Agency. Woodrow MG. 1999. *Gardening in India*. Biotech Books.
7. Roy, Rup Kumar. 2012 *Fundamentals of Garden Designing: A Colour Encyclopedia*. NIPA, New Delhi
8. Tiwari AK. 2016. *Fundamentals of Ornamental Horticulture and Landscape Gardening*, NIPA, New Delhi
9. Misra RL and Misra S. 2012. *Landscape Gardening*. Westville Publishing House, New Delhi

## HFL614 - PRODUCTION TECHNOLOGY OF CUT FLOWERS<sup>(m)</sup>

### THEORY

#### UNIT I

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India-Patent rights, nursery management, media for nursery, special nursery practices. Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soiled contamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO<sub>2</sub> on growth and flowering.

#### UNIT II

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes. Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation. Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones. **Crops:** Cutrose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliiums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliage and fillers.

### PRACTICALS

#### UNIT III

Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study. Visit of NRC on Orchids, Sikkim, UAS, Dharwad, NAU, Navsari, Gujarat, KAU, Thrissur, IIHR, Bengaluru, TNAU, Coimbatore, private companies in Bengaluru, Pune, BCKV, Kalyani, AAU, Jorhat.

### SUGGESTED READING

1. Arora JS. 2006. *Introductory Ornamental horticulture*. Kalyani. Bhattacharjee SK.2006.*Advances in Ornamental Horticulture*. Vols.I-VI. Pointer Publ.
2. Bose TK &Yadav LP. 1989. *Commercial Flowers*. Naya Prokash.
3. Bose TK, Maiti RG, Dhua RS &Das P. 1999. *Floriculture and Landscaping*. Naya Prokash.
4. Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.
5. Chadha KL.1995.*Advances in Horticulture*. Vol.XII. Malhotra Publ. House.
6. Lauria A & Ries VH.2001.*Floriculture–Fundamentals and Practices*. Agrobios.
7. Prasad S & Kumar U. 2003. *Commercial Floriculture*. Agrobios.
8. Randhawa GS & Mukhopadhyay A.1986. *Floriculture in India*. Allied Publ.
9. Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL.2007. *Hightech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi.
10. De LC. 2013. *Value Additions in Flowers and Orchids*, Biotech Publishing, Jodhpur

## **HFL615 - TURF AND TURF MANAGEMENT(m)**

### **THEORY**

#### **UNIT I**

Prospects of landscape industry; site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment. Turf grasses-Types, species, varieties, hybrids; Selection of grasses for different locations; Grouping according to climatic requirement- Adaptation; Turfing for roof gardens.

#### **UNIT II**

Preparatory operations; Growing media used for turf grasses - Turf establishment methods, seeding, sprigging / dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing. Turf management, Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing—mowing equipment, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs. Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, etc.

### **PRACTICALS**

#### **UNIT III**

Identification of turf grasses, Preparatory operations in turf making, Practices in turf establishment, 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 IT parks, model cricket and golf grounds, airports, corporates, Govt. organizations; Renovation of lawns; Turf economics. Visit of IARI, New Delhi.

### **SUGGESTED READING**

1. Nick-Christians 2004. Fundamentals of Turf grass Management.
2. Jain, Ritu and Janakiram, T. 2017. Turfing and Turf Management, NIPA, New Delhi.



## HFL622 - CAD FOR OUTDOOR AND INDOOR SCAPING<sup>(m)</sup>

### **THEORY**

#### **UNIT I**

Applications of CAD in landscape garden designing- 2D drawing by AUTOCAD- 3D drawing by ARCHICAD- 3D drawing by 3D MAX software- creating legends for plant and non-plant components- basics of photoshop software in garden designing - 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.

#### **UNIT II**

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 - 3D drawing methods- ARCHICAD file system- tools and infobox- modification tools- structural elements- GDL objects (Grid dimensional Linking)- creation of garden components through ARCHICAD.

#### **UNIT III**

ARCHICAD organization tools- dimensioning and detailing of designs- 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.

#### **PRACTICALS**

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- drawing designs with ARCHICAD for home garden- interior garden designing- it parks- corporates- theme parks and ecotourism spots-making sample drawing for indoor gardens.

#### **SUGGESTED READING**

1. Christine Wein-Ping Yu, 1987. Computer-aided Design: Application to Conceptual Thinking in Landscape Architecture. Agrobios Publishing Company, Jodhpur.
2. David Byrnes. 2010. Auto CAD 2010 for DUMMIES. Wiley Publishing Inc., UK.
3. Donnie Gladfelter. 2016. Auto CAD 2016 and Auto CAD LT. 2016. Autodesk Official Press, Wiley India.
4. Farin Gerald, E., Josef Hoschek and Myung-Soo Kim. 2002. Handbook of computer aided geometric design. Elsevier, Amsterdam.

## SUPPORTING COURSE CONTENTS

### HOR512 - BASIC STATISTICAL METHODS IN AGRICULTURAL RESEARCH<sup>(6)</sup>

#### UNIT I

Classification, tabulation and graphical representation of data. Levels of measurement. Descriptive statistics. Theory of probability. Random variable and mathematical expectation. Probability distributions: Binomial, Poisson, Normal distributions and their applications. Concept of sampling distribution: t,  $\chi^2$  and F distributions. Tests of significance based on normal, t,  $\chi^2$  and F distributions. Non-parametric tests.

Correlation and regression: Correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, simple and multiple linear regression model. Estimation of parameters. Coefficient of determination. Introduction to multivariate analytical tools: Principal component analysis and cluster analysis.

#### UNIT II

Planning of an experiment and basic principles of design of experiments. Analysis of variance. Completely randomized design (CRD), Randomized complete block design (RCBD), Latin square design (LSD). Randomization procedure, analysis and interpretation of results. Concept of factorial experiments. Planning of sample surveys. Sampling vs complete enumeration, Simple random sampling, Stratified sampling.

#### PRACTICALS

##### Unit III

Descriptive statistics. 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. Principal component analysis and cluster analysis. Analysis of data obtained from CRD, RBD, LSD. Analysis of data of factorial experiments. Selection of a random sample, estimation using simple random sampling. Exercises on stratified sampling.

#### SUGGESTED READING

1. Campbell, R.A. 1974. *Statistics for Biologists*. Cambridge University Press.
2. Cochran, W.G. and Cox, G.M. 1957. *Experimental Designs*. John Wiley.
3. Cochran, W.G. 1959. *Sampling Techniques*. John Wiley.
4. Das, M. N. and Giri, N.C. 1986. *Design and Analysis of Experiments*. New Age International.
5. Dillon, W.R. and Goldstein, M. 1984. *Multivariate Analysis: Methods and Applications*. John Wiley.
6. Goon, A.M., Gupta, M.K. and Dasgupta, B. 1977. *An Outline of Statistical Theory*. Vol. I. The World Press Pvt. Ltd.
7. Goon, A.M., Gupta, M.K. and Dasgupta, B. 1983. *Fundamentals of Statistics*. Vol. I. The World Press Pvt. Ltd.,
8. Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research*. John Wiley.
9. Gupta, S.C. and Kapoor, V.K. 2007. *Fundamentals of Mathematical Statistics*. Sultan Chand and Sons.
10. Panse, V.G. and Sukhatme, P.V. 1967. *Statistical Methods for Agricultural Workers*. ICAR Publication.
11. Siegel, S., Johan, N. and Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences*. John Wiley.
12. Snedecor, G.W. and Cochran, W.G. 1936. *Statistical Methods*. Oxford University.
13. Steel, R.G.D. and Torrie, J.H. 1960. *Principles and Procedures of Statistics*. McGraw Hill.

14. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. 1984. *Sampling Theory of Surveys with Applications*. Indian Society of Agricultural Statistics.
15. Katyal, Vijay. 2017. *Statistical Designs and Analysis for Agricultural Field Experiments*, NIPA, New Delhi
16. Gomez, K. A. and Gomez, A. A. 2015. *Statistical Procedure for Agricultural Research*. John Wiley & Sons, Indian Edition.

## **HOR611 - LIBRARY, INFORMATION AND TECHNICAL WRITING(S)**

### **THEORY**

#### **UNIT I**

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.).

### **PRACTICALS**

#### **UNIT II**

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.

#### **UNIT III**

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumets; 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.

#### **UNIT IV**

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, water bath, oil bath. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability.

### **SUGGESTED READING**

1. Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
2. Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
3. Sadasivam and Mannickkum. 2013. Handbook of Biochemical Methods, Biotech Books

## MINOR COURSE CONTENTS

HOR612 - ELECTIVE COURSES FROM OTHER COGNATE DEPARTMENTS<sup>(mi)</sup>

## **HOR613 - INTELLECTUAL PROPERTIES RIGHT AND ITS MANAGEMENT IN AGRICULTURE<sup>(mi)</sup>**

### **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 bio-diversity protection.

#### **UNIT II**

Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives.

#### **UNIT III**

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 READING**

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

**HOR621 - ELECTIVE COURSE FOR OTHER SPECIALIZATION (FROM VEGETABLES  
OR FLORICULTURE)<sup>(mi)</sup>**

## HOR522 – POST-HARVEST TECHNOLOGY OF HORTICULTURAL CROPS(m)

### THEORY

#### UNIT I

Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration.

Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage- ventilated, refrigerated, MA, CA storage, physical injuries and disorders. Role of Vitamins.

#### UNIT II

Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards. Excruder Technology.

### PRACTICALS

#### UNIT III

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cutflower using chemicals, estimation of quality characteristics in stored fruits and vegetables, cold chain management- visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products. Processing of sauces, ketchup, beverages. Analysis of curcumin. Visit to ICAR institutes like CISH, Lucknow, IARI, New Delhi, private companies at Sikkim, Tripura, Nagaon, Guwahati, IIHR, Bengaluru.

### SUGGESTED READING

1. Bhutani RC. 2003. *Fruit and Vegetable Preservation*. Biotech Books. & Pareek OP.(Eds.).1996 *Advances in Horticulture*. Vol.IV. Malhotra Publ. House.
2. Haid NF & Salunkhe SK. 1997. *Post-Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ.
3. Mitra SK.1997.*Post Harvest Physiology and Storage Sub-tropical Fruits*. CABI.
4. Ranganna S.1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.
5. Sudheer KP & IndiraV.2007.*Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.
6. Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. *Post-Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.
7. Tripathi, M. K. and Mangaraj, S. (2013) *Advances in Food Processing Technology*. Ed. 2013(1st). Pub: Narendra Publishing House, 1417, Kishan Dutt Street, Maliwara, Delhi-110006. Rashtriya Printers Delhi, India.



8. Sharma, S. K. and Nautiyal, M. C. (2009) Postharvest Technology of Horticultural Crop, Pub: New India Publishing Agency, 101 Vikas Surya Plaza, CU Block, L.S.C. mkt, Pitam Puram, New Delhi-110088. Jai Bharat Printing Press Delhi, India.
9. Kalia, M. (2006) Postharvest Technology of vegetables, Pub: Agro-tech Publishing Academy, 124, Anand Plaza, University Road, Udaipur-313001SSS. SSS printers New Delhi, India.
10. Gupta, S. (2012) Food Processing and Agro-based Industries, Pub: Engineer India Research Instt. 4499 NaiSarak, Main Road, Chawri Bazar, New Delhi-110006. Swastik Offset Delhi, India
11. Chakraverty, A., Majumdar, A. S., Raghavan, G. S. V. and Ramaswamy, H. S. (2010) Handbook of Postharvest Technology Cereals, Fruits, Vegetables, Tea and Spices, Pub: Marcel Dekker, Inc. 270, Madison Avenue, New York- 10016. Nutech Photolithographers, United States of America.

## **HFS517 - RESEARCH-I (SYNOPSIS SEMINAR)**

### **UNIT I**

Layout of field experiment, design of experiment, field preparation, meteorological parameters.

### **UNIT II**

Seminar on related research topic.

## **HOR526 - RESEARCH-II AND SEMINAR**

### **UNIT I**

Familiarization with field related practical activities and research oriented experiments. Chemical properties of experimental soil. Study of descriptors.

### **UNIT II**

Calculation of seed requirement—seed requirement for plantation, seed requirement for bed. Calculation of fungicides, pesticides and herbicide doses. Fertilizer dose and its calculation.

### **UNIT III**

Quantitative analysis of horticultural crops and their products.

### **UNIT IV**

Qualitative analysis of horticultural crops and their products.

### **UNIT V**

Operations of laboratory equipment-Digital Refractometer, Hand Refractometer, pH Meter, E C Meter, Spectrophotometer, Autoclave, Analytical Balance, Can Sealing machine, Table Top Centrifuge, Vertical Gel Electrophoresis Unit.

### **UNIT VI**

Criteria for judging maturity indices of horticultural crops. Handling of sprayers, safety measures for plant protection chemicals.

## **HFS 616 - RESEARCH III**

### **UNIT I**

Tabulation of quantitative data based on experimental design.

### **UNIT II**

Tabulation of qualitative data based on experimental design.

### **UNIT III**

Information about Review of literature.

### **UNIT IV**

Significance of primary data collection and their arrangement.

### **UNIT V**

Application of Statistical package for data analysis.

### **UNIT VI**

Interpretation of data.

## HFS624 - RESEARCH IV (DISSERTATION VIVA)

### UNIT I

Introduction about research topic

### UNIT II

Review of literature about research topic

### UNIT III

Materials and methods about research topic

### UNIT IV

Results and discussion about research topic

### UNIT V

Summary and conclusion about research topic

### UNIT VI

Bibliography about research topic

