

**ANNAMALAI UNIVERSITY**  
ANNAMALAI NAGAR 608 002.



**M.Sc., (HORTICULTURE) IN**  
**VEGETABLE SCIENCE**

**SYLLABUS**

**HAND BOOK**

**2022-2023**

**FACULTY OF AGRICULTURE**  
**COMMON REGULATIONS FOR ALL**  
**M.Sc. (AGRICULTURE/HORTICULTURE) AND MBA (AGRI. BUSINESS MANAGEMENT)**  
**PROGRAMMES OFFERED BY**  
**THE FACULTY OF AGRICULTURE**  
**WITH EFFECT FROM 2022-2023**

**1. Short title and commencement**

- These rules and regulations shall govern the post graduate studies leading to the award of degree of Master of Science (Agriculture/Horticulture) and MBA (Agri. Business Management) in the Faculty of Agriculture.
- They shall come into force with effect from the academic year 2022 – 2023.

**Academic Year and Registration**

- An academic year shall be normally from July to June of the following calendar year otherwise required under special situations. It shall be divided into two academic terms known as semesters. The Academic Calendar will be developed by the University from time to time and notified accordingly by the Registrar in advance.
- An orientation programme shall be organized by the Dean, Faculty of Agriculture for the benefit of the newly admitted students immediately after commencement of the semester.
- On successful completion of a semester, the continuing students shall register for subsequent semester on the date specified in the Academic/ Semester Calendar or specifically notified separately. Every enrolled student shall be required to register at the beginning of each semester till the completion of his/ her degree programmes

**Registration Cards**

- A student shall register the courses offered in a semester by writing all the courses in registration card in quadruplicate.
- The Chairman, PG coordinator and Head of the Department are responsible to furnish the registration particulars of the students with their signature in the Registration card to the Dean.
- The Dean shall approve the registration cards.
- The approved registration cards shall be maintained by the Head of the Department, Chairman and the student concerned.
- The list of courses registered by the students in each semester shall be sent by the Dean to the Controller of Examinations/University for preparation of Report Cards

## 2. Definitions

- “Semester” means an academic term consisting of 110 working days including final theory examinations.
- “Subject” means a unit of instruction to be covered in a semester having specific No., title and credits.
- “Credit hour” means, one hour lecture plus two hours of library or homework or two and half 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.

## 3. Courses offered

The details of various post-graduate degree programmes at Masters’ level offered in the Faculty of Agriculture are as follows:

- Agronomy
- Entomology
- Agricultural Microbiology
- Genetics and Plant Breeding
- Seed Science and Technology
- Plant Molecular biology and Biotechnology
- Horticulture -
  - Fruit Science
  - Vegetable Science
  - Floriculture and Landscaping
  - Plantation, Spices, Medicinal and Aromatic Crops
- Plant Pathology
- Soil Science and Agricultural Chemistry
- Agricultural Extension
- Agricultural Economics
- M.B.A (Agri. Business Management)

#### **4. Eligibility for admission**

Candidates for admission to the M.Sc. (Ag. /Hort.) programme should satisfy the following requirements.

4.1. Candidates seeking admission to the M.Sc. (Ag. /Hort.) Degree programme should have completed any one of the following four-year degree programmes from Faculty of Agriculture, Annamalai university or Universities/colleges accredited with ICAR, New Delhi.

- **For M.Sc. (Ag.) Agronomy**

Eligibility: B.Sc. (Hons.) Agriculture / B.Sc. (Ag.) courses of four years duration.

- **For M.Sc. (Ag.) Entomology, Genetics and Plant Breeding, Plant Pathology, Soil Science and Agricultural Chemistry, Seed Science and Technology, Plant Molecular biology and Biotechnology, Agricultural Microbiology, Agricultural Extension, Agricultural Economics and M.B.A (Agri. Business Management)**

Eligibility: B.Sc. (Hons.) Agriculture / B.Sc. (Hons.) Horticulture/B.Sc. (Ag.)/B.Sc. (Hort.) of four years duration.

- **For M.Sc. (Hort.)**

Eligibility: B.Sc. (Hons.) Agriculture / B.Sc. (Hons.) Horticulture/ B.Sc. (Hort.) and B.Sc. (Ag.) courses of four years duration.

4.2. Candidates who have undergone the programme under conventional system should possess not less than a second-class Bachelor's degree. The candidates under 4-point grade systems should possess a minimum OGPA of 2.5 out of 4.00 and 2.75 out of 4.00 in the subject concerned. For those under 10-point system a minimum OGPA of 6.50 out of 10.00 and 7.00 out of 10.00 in the subject concerned is required. However, for SC/ST candidates OGPA of 6.75 out of 10.00 in the subject concerned is sufficient.

4.3. An entrance test will be held separately for each Degree programme. Selection of candidates shall be based on OGPA, Subject OGPA, Entrance Test and Interview

4.4. A student can apply to a maximum of two subjects only

#### **5.1. Residential requirements**

The duration for the M.Sc. (Agriculture/Horticulture) and MBA programme will be of two years with four semesters. A student registered for M.Sc. (Agriculture /Horticulture) programme should complete the course within five Academic year from the date of his/her admission.

In case a student fails to complete the degree programme within the maximum duration of residential requirement, his/ her admission shall stand cancelled. The requirement shall be treated as satisfactory in the cases in which a student submits his/ her thesis any time during the 4th semester of his/ her resident ship at the University.

## 5.2 Credit Grade Point Requirements

A student enrolled for the Master's degree programme to earn eligibility for the degree is required to complete 70 credits as detailed below.

### I) Course work

Major Courses	20
Minor Courses	08
Supporting Courses	06
Common Courses	05
Seminar	01
ii) Thesis Research	30
<b>Total credits</b>	<b>70</b>

**Major courses:** From the Discipline in which a student takes admission. Among the listed courses, the core courses compulsorily to be taken will be given \*mark

**Minor courses:** From the courses closely related to a student's major subject chosen by the students in consultation with the Head of the department and the Chairman based on their research specialization.

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

- a. List of supporting courses for M.Sc. (Ag.) Agronomy, Agricultural Entomology, Genetics and Plant Breeding, Plant Pathology, Soil Science and Agricultural Chemistry, Seed Science and Technology, Plant Molecular biology and Biotechnology, Agricultural Microbiology and Horticulture are

STA 501	Statistical Methods for Applied Sciences	3 (2+1)
COM 501	Information Technology in Agriculture	3 (2+1)

- b. List of supporting courses for M.Sc. (Ag.) Agricultural Extension, Agricultural Economics and M.B.A (Agri. Business Management)

STA 502	Statistical Methods for social Sciences	3 (2+1)
COM 501	Information Technology in Agriculture	3 (2+1)

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

1. PGS 501 - Agricultural Research, Research Ethics and Rural Development Programmes (1+0)
2. PGS 502 - Technical Writing and Communications Skills (1+0)
3. PGS 503 - Basic Concepts in Laboratory Techniques (0+1)
4. PGS 504 - Library and Information Services (1+0)
5. PGS 505 - Intellectual Property and its management in Agriculture (1+0)

Some of these courses are already in the form of e-courses/ MOOCs. The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these

courses during UG, he/ she may be permitted to register for other related courses with the prior approval of the Head of Department (HoD)/ Board of Studies (BoS).

#### **5.4. Minimum Grade point requirement**

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 which a student fails, he/she has to reappear for the examination to get a pass in that subject.

#### **6. Attendance requirement**

6.1. One hundred per cent attendance is expected of each student. A student, who fails to secure a minimum of **80 per cent** of attendance in each subject separately for theory and practical, shall not be permitted to appear for the final examination in that subject and will be required to repeat the subject when ever 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, Faculty of Agriculture on payment of condonation fee prescribed by the University.

6.2 Students absenting from the classes with prior permission of the Head of the Department/Dean, Faculty of Agriculture on official University business shall be given due consideration in computing attendance.

#### **7. Advisory Committee**

7.1. Each post-graduate student shall have an Advisory Committee to guide him/her in carrying out the research programme. The Advisory Committee shall comprise a Major Advisor (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 of Faculty of Agriculture. The Advisory Committee shall be constituted within three weeks from the date of commencement of the first semester.

7.2 For interdisciplinary research requiring expertise from teaching staff of other faculties, due permission need to be obtained from the Dean, Faculty of Agriculture to nominate them as technical advisors. An official letter in this regard needs to be communicated to the individual concerned. However, they are restrained from the evaluation of Research/Seminar evaluation.

#### **7.3. Major Advisor (Chairman)**

Every student shall have a Major Advisor who will be from his/her major field of studies. The appointment of Major Advisor (Chairman) shall be made by the Head of the Department concerned. The chairman in consultation with the Head of the Department will nominate the other two members. In the event of the Major Advisor being away on other duty/leave for a period of more than three months, the member of the Advisory Committee from the same Department will officiate as the Major Advisor.

### **Advisor/ Co-guide/ Member, Advisory Committee from other collaborating University/ Institute/ Organization**

- In order to promote quality post-graduate research and training in cutting edge areas, the University will enter into Memorandum of Understanding (MOU) with other Universities/ Institutions for conducting research. While constituting an Advisory Committee of a student, if the Chairperson, Advisory Committee feels the requirement of involving of a faculty member/ scientist of such partnering university/ Institute/ Organization, he/ she may send a proposal to this effect to the Dean, Faculty of Agriculture along with the proposal for consideration of Student's Advisory Committee.
- The proposed faculty member from the partnering institution can be allowed to act as Chairperson/ Co-guide/ Member, SAC, by mutual consent, primarily on the basis of intellectual input and time devoted for carrying out the research work at the particular institution.

### **Allotment of students to the retiring persons**

Normally, retiring faculty may not be allotted with M. Sc. Student if he/ she is left with less than 2 years of service.

### **Changes in the Advisory Committee:**

- i. Change of the Chairperson or any member of the Advisory Committee is not ordinarily permissible. However, in exceptional cases, the change may be effected with due approval of the Dean, faculty of Agriculture.
- ii. Normally, staff members of the university on extra ordinary leave or on study leave or who leave the University service will cease to continue to serve as advisors of the post-graduate students of the University. However, the Dean, faculty of Agriculture may permit them to continue to serve as advisor subject to the following conditions:
  - a) The concerned staff member must be resident in India and if he/ she agrees to guide research and must be available for occasional consultations;
  - b) An application is made by the student concerned duly supported by the Advisory Committee;
  - c) The Head of the Department and the Dean, Faculty of Agriculture agree to the proposal;
- iii. In case the Chairperson/ member of Advisory Committee retires, he/ she shall be allowed to continue provided that the student has completed his course work and minimum of 10 research credits and the retiring Chairperson/ member stays at the Headquarters of the College, till the thesis is submitted.
- iv. The change shall be communicated to all concerned by the Head of Department.

### **7.4. Guidelines on the duties of the Advisory Committee**

- Guiding students in drawing the outline of research work
- Guidance throughout the programme of study of the students.
- Evaluation of research and seminar credits.
- Correction and finalization of thesis draft.
- Conduct of final Viva-Voce examination.

- The proceedings of the Advisory Committee will be sent to the Head of the Department concerned within 10 working days.
- Periodical review of the Advisory Committee proceedings will be made by the Head of the Department concerned.

### **8. Programme of Study**

- 8.1 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.
- 8.2 The programme shall be planned by the Advisory Committee taking into account his/her previous academic training and interest.
- 8.3 Programme 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.

### **9. EVALUATION OF STUDENTS' PERFORMANCE**

Multiple levels of evaluation (First Test, Midterm and Final semester) will be conducted

#### **9.1 First Test (FT) and Mid-semester examination (MSE)**

- 9.1.1 Every teacher handling a subject shall conduct first Test (FT) as per the scheme drawn by the Head of the Department concerned /PG coordinator on the fourth week from the date of registration of the course, and evaluate. The evaluation process will be based on objective type questions and short concepts.
- 9.1.2 Every teacher handling a subject shall conduct Mid-Semester Examination (MSE) as per the scheme drawn by the Head of the Department concerned /PG coordinator, on the sixth week from the date of registration of the course and evaluate. The evaluation process will be of descriptive type.
- 9.1.3 The answer scripts of both FT and MSE will be shown to the student after valuation, and returned to the course teacher. The Head of the Department will be responsible to ensure the distribution of answer papers to the students. The marks obtained by the students should be sent to the Controller of Examinations through the Head of the Department concerned within fifteen working days.
- 9.1.4 Writing the first test and mid-semester examination is a pre-requisite for writing the final theory and practical examinations. If a student does not appear for FT/MSE, he/she is not eligible to appear for the final examinations. Such candidate has to reappear for the FT/MSE as and when the respective examinations are conducted only after getting permission from the Head of the Department concerned.
- 9.1.5 The FT and MSE marks will not be shown separately in the grade sheet but will be combined with the respective final theory and practical marks. FT and MSE marks awarded in a course will be added to the supplementary examinations also.



- 9.1.6 The FT and MSE marks will be furnished to the Head of the Department within 10 days after the conduct of Ft and MSE. If the student is not satisfied with the award of the marks, he/she shall appeal to the Dean, through Head of the Department within three working days after the announcement of marks. The appeal will be considered and the results reviewed by a Cell consisting of the Dean and the Head of the Department concerned. The decision of the Review Cell shall be final. If the Head of the Department himself is the course teacher, one senior member of the department concerned shall be nominated by the Dean.
- 9.1.7 The first test will be of 30 minutes duration and MSE of theory will be of one hour duration.
- 9.1.8 If the student is not able to write the FT/ MSE due to deputation by the University, he/she may be permitted to take up missing FT/MSE. Such examination should be completed ordinarily within 15 working days after the respective Ft/MSE.
- 9.1.9 A student who fails to attend a first test and mid-semester examination due to unavoidable circumstances shall be permitted with prior approval of the head of the Department to take up missing examination of the particular course. Such tests should be completed ordinarily within 15 working days after the respective FT/MSE.

The distribution of marks will be as indicated below.

Test	Subjects with Practical	Subjects without Practical	Subjects without Theory
First test	10	20	20
Mid-Semester	20	30	30
Final theory	30	50	-
Final practical	40	-	50
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>

The question paper model and distribution of marks for Mid Semester examinations is as follows.

**First Test (30 minutes duration) (Total Marks: 10)**

1. Objective Type	10 out of 12	10 x 0.5 marks	5 Marks
2. Definitions/ Short Concepts	5 out of 7	5 x 1 marks	5 Marks

**Mid-semester examination**

**For Subjects with practicals (One hour duration) (Total marks: 20)**

1. Objective Type	10 out of 12	10 x 0.5 marks	5 Marks
2. Definitions/ Concepts	5 out of 7	5 x 1 marks	5 Marks
3. Short Notes	2 out of 3	2 x 2 ½ marks	5 Marks
4. Essay Type	1 out of 2	1 x 5 marks	5 Marks

**For Subjects without practicals (One hour duration) (Total marks: 30)**

1. Objective Type	10 out of 12	10 x 0.5	5 Marks
2. Definitions/ Concepts	5 out of 7	5 x 1	5 Marks
3. Short Notes	4 out of 5	4 x 2 ½	10 Marks
4. Essay Type	2 out of 3	2 x 5	10 Marks

**9.2. Final examinations**

9.2.1. The final theory and practical examinations will be of two and a half hours duration each conducted separately by the University.

9.2.2. The final theory and practical examinations will be evaluated by respective course teacher)

9.2.3. The question papers for the final theory examinations will be set by the external examiners.

The question paper model and distribution of marks for final theory examinations are as follows.

**Final theory examination****For subjects with practical (2½ hour duration) (Total marks: 30)**

1. Definitions	5 out of 7	5 x 1 marks	5 marks
2. Short Notes	2 out of 3	2 x 2½ marks	5 marks
3. Essay Type	Either or type (One question from each unit)	5 x 4 marks	20 marks

**For subjects without practicals (2½ hour duration) (Total marks: 50)**

1. Definitions	6 out of 8	6 x 1 marks	6 marks
2. Short Notes	3 out of 5	3 x 3 marks	9 marks
3. Essay Type	Either or type (One question from each unit)	5 x 7 marks	35 marks

**9.2.4. Practical Examination**

Practical examinations will be conducted in the last practical class. Proper maintenance and regular submission of practical records are required. Those who do not bring with them the certified practical records/ specimen collection/ assignments will not be allowed to appear for the practical examination. The marks awarded for specimen collection and assignments shall be noted in the record, at the time of first appearance and will be taken into account for subsequent appearances.

**9.2.5. Assignment**

Each student will be assigned a topic by the concerned course teacher. Such topic should cover a wide range of topics within the subject limits. The topic should be different from that of the credit seminar. Assignments will be evaluated during practical examination.

The distribution of marks for final practical examination for courses with theory and practical and only practical is as follows:

S. No.	Particulars	Courses with theory and practical	Courses only with practical
1	Practical part	25	55
2	Assignment/specimen collection	5	5
3	Record	5	5
4	Viva voce	5	5
<b>Total</b>		<b>40</b>	<b>70</b>

**The pattern of practical part should be uniform in each Department**

### 9.3. 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 **80 per cent** will be awarded 'E' grade and has to repeat the subject.

### 9.4. Class/ Percentage ranking

In calculation of percentage and class equivalent for OGPA the following classification shall be adopted.

OGPA	Percentage	Class
9.00 and above	90 and above	Distinction
8.00 to 8.99	80.00 to 89.99	I Class
7.00 to 7.99	70.00 to 79.99	II Class
6.50 to 6.99	65.00 to 69.99	Pass

## 10. Credit Seminar

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

- 10.1 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.

- 10.2. 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.
- 10.3. The circular on the seminars by the post-graduate students shall be sent to other Departments to enable those interested to attend the same.
- 10.4. 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 time. 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.
- 10.5 The performance of the student has to be evaluated for 100 marks and Grade Point will be awarded by 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>

**11. Absence of advisory committee member during final viva-voce examination:**

- 11.1 Conducting final viva voce examination in the absence of advisory committee members is not allowed.
- 11.2. Under extra-ordinary circumstances if the 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.
- 11.3. The co-opted member should be from the same department of the member who is not attending the examinations.
- 11.4. In the absence of the Chairman of advisory committee, respective Heads of Departments should act as Co-chairman with prior permission of Dean.

## 12. Research Work

12.1. 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 of the Department concerned. After assigning the topic, each student may be instructed to submit a detailed programme of work to be carried out by him/her during the semester in the prescribed proforma. After scrutiny and approval, a copy of the programme 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 programme.

12.2. The distribution of research credits will be as follows:

I Semester	0+ 2
II Semester	0+ 6
III Semester	0+ 10
IV Semester	0+ 12*
<b>Total</b>	<b>0 + 30</b>

**\* In the fourth semester out of 12 credits, 8 credits will be for evaluation of research and remaining 4 credits for evaluation of viva voce.**

## 13. Evaluation of Thesis Research

13.1. Attendance register must be maintained in the department by HOD / chairman for all the students to monitor whether the student has 80% of attendance in research.

13.2. The student has to submit his/her research observation note book to the major Advisor. The major Advisor 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.

13.3. After completion of 80% 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.

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

### Situation - I

The students have 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 **80 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'.

- 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.

## **14. Submission of Thesis**

14.1. 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 Advisor (Chairman) shall accompany the thesis.

14.2 The research credits registered in the last semester of post graduate programmes 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 per cent attendance

requirement. Two copies of the thesis should be submitted in paper pack for evaluation to the HOD.

- 14.3 The thesis shall contain a certificate from the supervisor specifying that the thesis submitted is a record of research work done by the candidate during the period of study under him/her, and that the thesis has not previously formed the basis for the award of any Degree, Diploma, Associateship, Fellowship or similar title. A statement from the supervisor indicating the extent to which the thesis represents independent work on the part of the candidate should also be made including free from plagiarism **above the specified level.**
- 14.4 The thesis shall also contain a declaration by the candidate that the work reported in the thesis has been carried out by the candidate himself/herself and that the material from other sources, if any, is duly acknowledged and no part of the thesis is plagiarized **more than 25 %.**

### **15. Grace period**

- 15.1 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.
- 15.2 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.

### **16. Submission of thesis after re-registration**

The minimum of 80 per cent 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.

### **17. Publication of articles**

Part of the thesis may also be published in advance with the permission of the HOD. If any part is published the fact should be indicated in the certificate given by the chairman that the work has been published in part/full in the scientific or popular journals, proceedings, etc. The copies are to be enclosed in the thesis at the time of submission.

### **18. Evaluation of Thesis**

- 18.1 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 Annamalai University and shall be appointed by the University as per the recommendation of the Head of the Department.
- 18.2 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 favourable, Viva-Voce will be

- arranged by the Head of the Department concerned and conducted by the Advisory Committee along with the external examiner. 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.
- 18.3 In case of rejection of the thesis by the external examiner the Head of the Department concerned and Advisory Committee refer the thesis for valuation by a second external examiner. If the second external examiner recommends the thesis for acceptance, Viva-Voce will be conducted.
- 18.4 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.
- 18.5 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.

## **19. Revision of thesis**

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

- 19.1 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
- 19.2 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.
- 19.3 A fine prescribed by the University to be collected from the students at the time of resubmission of thesis.

## **20. Failure to appear for final Viva-voce/ Non submission of thesis after viva-voce.**

- 20.1 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.
- 20.2 The re-viva-voce must be completed within two years. An amount of fine prescribed by the University must be charged to the candidate.



- 20.3 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.

## **21. Internship during Masters programme**

### **Internship for Development of Entrepreneurship in Agriculture (IDEA)**

Currently, a provision of 30 credits for dissertation work in M.Sc. programmes helps practically only those students who aspire to pursue their career in academic/research. There is hardly any opportunity/provision under this system to enhance the entrepreneurship skills of those students who could start their own enterprise or have adequate skills to join the industry.

Therefore, in order to overcome this gap, an optional internship/ in-plant training (called as IDEA) in lieu of thesis/ research work is recommended which will give the students an opportunity to have a real-time hands-on experience in the industry. It is envisaged that the internship/ in-plant training would enhance the interactions between academic organizations and the relevant industry. It would not only enable the development of highly learned and skilled manpower to start their-own enterprises but also the industry would also be benefitted through this process. This pragmatic approach would definitely result in enhanced partnerships between academia and industry.

The main objectives of the programme:

1. To promote the linkages between academia and industry
2. To establish newer University - Cooperative R&D together with industry for knowledge creation, research and commercialization
3. Collaboration between Universities and industries through pilot projects
4. To develop methods for knowledge transfer, innovation and networking potential
5. To enhance skill, career development and employability

Following criteria for IDEA will be taken into consideration:

- At any point of time there will not be more than 50% of students who can opt under IDEA
- Major Advisor will be from Academia and Co-advisor (or Advisory Committee member) from industry
- Total credits (30) will be divided into 20 for internship/ in-plant training and 10 for writing the report followed by viva-voce similar to dissertation
- Work place will be industry; however, academic/ research support would be provided by the University or both. MoU may be developed accordingly
- The IPR, if any, would be as per the University policy

## **22. Result notification**

- 22.1 After the completion of each semester, the student will be given the statement of marks by the Controller of Examinations.
- 22.2 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.

### **23. Award of Medals**

Medal should be awarded only if the student is a rank holder and secures at least 8.5 OGPA, clears all courses in first attempt and in the programme having a batch of at least three students.

\*\*\*\*\*

**M.Sc. (Hort.) in Vegetable science**  
**Courses with Credit Load**

<b>I) Course work</b>	
Major Courses	<b>20</b>
Minor Courses	<b>08</b>
Supporting Courses	<b>06</b>
Common Courses	<b>05</b>
Seminar	<b>01</b>
<b>II) Thesis Research / IDEA</b>	<b>30</b>
<b>Total credits</b>	<b>70</b>

**Distribution Pattern of Courses and Credit (For Research Program)**

Semester	Major Courses	Minor Courses	Supporting Courses	Common Courses	Seminar	Research	Credit Load
I	8	-	6	2	-	2	18
II	12	-	-	2	-	6	20
III	-	6	-	1	1	10	18
IV	-	2	-	-	-	12	14
Credit Load	<b>20</b>	<b>8</b>	<b>6</b>	<b>5</b>	<b>1</b>	<b>30</b>	<b>70</b>

**Distribution Pattern of Courses and Credit (For IDEA Program)**

Semester	Major Courses	Minor Courses	Supporting Courses	Common Courses	Seminar	IDEA	Credit Load
I	8	-	6	2	-	-	16
II	12	-	-	2	-	-	14
III	-	6	-	1	1	10	18
IV	-	2	-	-	-	10 +10	22
Credit Load	<b>20</b>	<b>8</b>	<b>6</b>	<b>5</b>	<b>1</b>	<b>30</b>	<b>70</b>

**Distribution Pattern of Courses and Credit M.Sc., (Hort.) in Vegetable science**

S.no.	Course Code	Course Title	Credit Hours
		<b>Major Courses</b>	
1	VSC 501*	Production of Cool Season Vegetable VSC Crops	2+1
2	VSC 502*	Production of Warm Season Vegetable Crops	2+1
3	VSC 503*	Growth and Development of Vegetable Crops	2+1
4	VSC 504*	Principles of Vegetable Breeding	2+1
5	VSC 505	Breeding of Self-Pollinated Vegetable Crops	2+1
6	VSC 506	Breeding of Cross-Pollinated Vegetable Crops	2+1
7	VSC 507	Protected Cultivation of Vegetable Crops	1+1
8	VSC 508	Seed Production of Vegetable Crops	2+1
9	VSC 509	Production of Underutilized Vegetable Crops	2+1
	VSC 510	Systematics of Vegetable Crops	1+1
	VSC 511	Organic Vegetable Production	1+1
		<b>Minor Courses</b>	
10	VSC 512	Production of Spice Crops	2+1
11	VSC 513	Processing of Vegetable	1+1
12	VSC 514	Postharvest Management of Vegetable Crops	2+1
		<b>Supporting courses</b>	
13	STA 501	Statistical Methods for Applied Sciences	2+1
14	COM 501	Information Technology in Agriculture	2+1
		<b>Common Courses</b>	
15	PGS 501	Agricultural Research, Research Ethics and Rural Development Programmes	1+0
16	PGS 502	Technical Writing and Communications Skills	1+0
17	PGS 503	Basic Concepts in Laboratory Techniques	0+1

18	PGS 504	Library and Information Services	1+0
19	PGS 505	Intellectual Property and its Management in Agriculture	1+0
20	VSC 591	Seminar	0+1
21	VSC 599	Research	30

\*Compulsory courses

<b>Programme Outcomes (POs)</b>
<b>PO 1.</b> Students will have core knowledge leading to awareness on advancements in the field of Vegetable Science including crop production, soil fertility, crop protection, crop improvement. Biotechnology, post-harvest technologies and economics of cultivation.
<b>PO 2.</b> Students will have understanding and skill on experimental tools in biological sciences, analytical techniques for plant and soil samples, microbial technologies, biotechnological breeding methods, statistical tools & analysis, research data computation, etc, required for higher learning in Vegetable Science.
<b>PO 3.</b> Students will be mastering the modern horticulture techniques of crop production, water, soil & nutrient management, plant protection, crop improvement and ecosystem restoration.
<b>PO 4.</b> Students be able design and execute individual research project, write concise & persuasive research articles and communicate effectively with their scientific colleagues, farmers and the general public
<b>PO 5.</b> Students become eligible to work in commercial horticultural units, research project, post-harvest industries and POS.be able to address complex problems taking into account related ethical, social, legal, economic, and environmental issues

### PO and CO Mapping Matrix

#### AFFINITY LEVELS

1	<b>Low</b>
2	<b>Moderate/ Medium</b>
3	<b>Substantial /High</b>

### SEMESTER WISE DISTRIBUTION OF COURSES (RESEARCH)

Sl. No.	Course Title	Credit hours
<b>I Semester</b>		
1.	Major Courses	8
2.	Supporting Courses	
	STA 501 - Statistical Methods for Applied Sciences	3
	COM 501 - Information Technology in Agriculture	3
3.	Common Courses	
	PGS 501 - Agricultural research, research ethics and rural development programmes	1
	PGS 502 - Technical writing and communications skills	1
4.	VSC 599 Research	2
	<b>Total</b>	<b>18</b>
<b>II Semester</b>		
1.	Major Courses	12
2.	Common Courses	
	PGS 503 - Basic Concepts in Laboratory Techniques	1
	PGS 504 - Library and information services	1
3.	VSC 599 Research	6
	<b>Total</b>	<b>20</b>
<b>III Semester</b>		
1.	Minor courses	6
2.	Common course	
	PGS 505 - Intellectual property and its management in agriculture	1
3.	Disaster Management (1+ 0)	-
4.	Constitution of India (Contact hour 1+ 0)	-
5.	VSC 591 Seminar	1
6.	VSC 599 Research	10
7.	Value Added Course (3+0) ( <a href="https://annamalaiuniversity.ac.in/studport/value_added_crs.php">https://annamalaiuniversity.ac.in/studport/value_added_crs.php</a> )	-
	<b>Total</b>	<b>18</b>
<b>IV Semester</b>		
1.	Minor course	2
2.	VSC 599 Research	12 (8+4)
	<b>Total</b>	<b>14</b>

### SEMESTER WISE DISTRIBUTION OF COURSES (IDEA)

Sl. No.	Course Title	Credit hours
<b>I Semester</b>		
4.	Major Courses	8
5.	Supporting Courses	
	STA 501 - Statistical Methods for Applied Sciences	3
	COM 501 - Information Technology in Agriculture	3
6.	Common Courses	
	PGS 501 - Agricultural research, research ethics and rural development programmes	1
	PGS 502 - Technical writing and communications skills	1
4.	VSC 599 IDEA	
	<b>Total</b>	<b>16</b>
<b>II Semester</b>		
4.	Major Courses	12
5.	Common Courses	
	PGS 503 - Basic Concepts in Laboratory Techniques	1
	PGS 504 - Library and information services	1
6.	VSC 599 IDEA	
	<b>Total</b>	<b>14</b>
<b>III Semester</b>		
1.	Minor courses	6
2.	Common course	
	PGS 505 - Intellectual property and its management in agriculture	1
3.	Disaster Management (1+ 0)	-
4.	Constitution of India (Contact hour 1+ 0)	-
5.	VSC 591 Seminar	1
6.	VSC 599 IDEA	10
7.	Value Added Course (3+0) ( <a href="https://annamalaiuniversity.ac.in/studport/value_added_crs.php">https://annamalaiuniversity.ac.in/studport/value_added_crs.php</a> )	-
	<b>Total</b>	<b>18</b>
<b>IV Semester</b>		
1.	Minor course	2
2.	VSC 599 IDEA	20 (10+10)
	<b>Total</b>	<b>22</b>

**ANNEXURE-1**  
**PROFORMA FOR FORMATION OF RESEARCH ADVISORY COMMITTEE**  
**(To be sent before the end of I Semester)**

1. Name of the student:
2. Enrolment number: Reg. No.:
3. Degree:
4. Subject:
5. Advisory Committee:

S.No.	Advisory Committee	Name, Designation and Department	Signature
1.	Chairperson		
2.	Members		
	Additional Member		
	Reasons for additional Member		

Professor and Head

Additional members may be included only in the allied faculty related to thesis research with full justification at the time of sending proposals (Program of research).



**ANNEXURE-II**  
**PROFORMA FOR CHANGE IN THE RESEARCH ADVISORY COMMITTEE**

1. Name of the student:
2. Enrolment number: Reg. No.
3. Subject:
4. Degree:
5. Proposed Change:

Advisory Committee	Name and designation	Signature
a. Existing member		
b. Proposed member		

6. Reasons for change

Chairperson

Signature of Professor and Head

**ANNEXURE-III**  
**PROFORMA FOR OUTLINE OF RESEARCH WORK (ORW)**  
**(To be sent before the end of I Semester)**

1. Name:
2. Enrolment number: Reg. No.
3. Degree:
4. Subject:
5. Date of Joining:
6. Title of the research project:
7. Objectives:
8. Duration:
9. Review of work done:
10. Broad outline of work/methodology:
11. Semester wise break up of work:

Signature of student

Approval of the advisory committee

<b>Advisory committee</b>	<b>Name</b>	<b>Signature</b>
Chairperson		
Members		
1.		
2.		

Professor and Head

**ANNEXURE-IV**

**PROFORMA FOR CHANGE IN OUTLINE OF RESEARCH WORK (ORW)**

1. Name:
2. Enrolment number: Reg. No
- 3 Degree:
- 4 Subject
- 5 Reasons for change:
- 6 Proposed change in the approved Program of research:
- 7 Number of credits completed so far Under the approved program:
- 8 a. Whether already earned credits are to be retained or to be deleted:  
c. if retained, justification:

Signature of the student

**Approval of the Advisory Committee**

<b>Advisory committee</b>	<b>Name</b>	<b>Signature</b>
Chairperson		
Members		
Intra		
Inter		

Professor and Head

**ANNEXURE-V**  
**DEPARTMENT OF HORTICULTURE**  
**PROFORMA FOR EVALUATION OF SEMINAR**

1. Name of the candidate:
2. Register Number :
3. Degree programme :
4. Semester :
5. Topic of the seminar  
and credit :
6. Distribution of marks

Distribution of marks	Max Marks				
i. Literature coverage	40				
ii. Presentation	30				
iii. Use of audio - visual aid	10				
iv. Interactive skills	20				
Total	100				
Name					
Designation		Chairperson	Intra Member	Inter Member	Average
Signature					

Grade point:

Head of the Department

**ANNEXURE-VI**  
**PROFORMA FOR REGISTRATION OF RESEARCH CREDITS**

(To be given during first week of semester)

**PART A: PROGRAM**

Semester:

Year:

Date of registration:

1. Name of the student and
2. Enrolment number:/Reg. No.:
3. Total research credits completed so far:
4. Research credits registered during the semester:
5. Program of work for this semester (list out the  
Items of research work to be undertaken during  
the semester) :

Approval of advisory committee

<b>Advisory committee</b>	<b>Name</b>	<b>Signature</b>
Chairperson		
Members		
1. Intra		
2. Inter		

Professor and Head

*Approval may be accorded within 10 days of registration*

**ANNEXURE-VII**  
**PROFORMA FOR EVALUATION OF RESEARCH CREDITS**  
**PART B EVALUATION**  
**(Evaluation to be done before the closure of Semester)**

Date of Commencement semester:

Date of closure of semester:

Date of evaluation:

1. Name of the student
2. Enrolment number: Reg. No.:
3. Total research credits completed so far:
4. Research credits registered during the semester:
5. Whether the research work has been carried out as per the approved program:
6. If there is deviation specify the reasons:
7. Performance of the candidate: SATISFACTORY /NOT SATISFACTORY

**Approval of the advisory committee**

<b>Advisory committee</b>	<b>Name</b>	<b>Signature</b>
Chairperson		
Members		
1.Intra		
2.Inter		

Professor

**ANNEXURE- VIII  
ANNAMALAI UNIVERSITY  
FACULTY OF AGRICULTURE  
DEPARTMENT OF HORTICULTURE  
PROFORMA FOR EVALUATION OF THESIS**

1. Name of the examiner:
2. Postal Address:
3. Telephone/Mobile:
4. E-Mail:
5. Name of the candidate:
6. Title of the thesis:
7. Date of receipt of the thesis copy:
8. Date of dispatch of the detailed report and thesis by the examiner to the Controller of Examinations:
9. Examiner's recommendations choosing one of the following based on quality of thesis  
Please give your specific recommendation (select any one decision from the list below) with your signature and enclose your detailed report in separate sheet(s).

a. I recommend that the thesis entitled -----  
-----  
submitted by ----- be accepted for award of the Degree of MASTER OF SCIENCE (AGRICULTURE / HORTICULTURE / AGRI BUSINESS MANAGEMENT ) of Annamalai University, Annamalainagar.

**(OR)**

b. I do not recommend the acceptance of the thesis entitled.  
-----  
----- Submitted by -----  
for award of the Degree of MASTER OF SCIENCE (AGRICULTURE / HORTICULTURE / AGRI BUSINESS MANAGEMENT) of Annamalai University, Annamalainagar. (Please specify reasons)

Date:

Signature with Office Seal:

**Note- Please enclose a detailed report in duplicate duly signed by you giving the merits and demerits of the thesis on the choice of problem, review of literature, methods followed, results and discussion, etc.**

**PROFORMA FOR REPORT OF THE FINAL VIVA VOCE EXAMINATION**

The meeting of the Examining Committee for Mr./Ms. -----M.Sc. (Ag.)  
Student Reg.No. ----- Majoring in -----was held at -----a.m  
/p.m on -----

The following members were present:

- 1.----- : Chairperson
- 2.----- : Member
- 3.----- : Member
- 4.-----: External examiner

The committee took note of the report of the external examiner Dr. -----recommending the thesis for acceptance.

The final viva voce examination for the candidate was conducted by the members of the Advisory Committee and external examiner. The candidate has secured satisfactory/unsatisfactory

The Committee recommends/ does not recommend unanimously the award of Degree of M.Sc. (Ag.) to Mr./Ms.-----

1. Chairman
2. Member
3. Member
4. External examiner:

The original report from the External Examiner is attached herewith

Professor and Head

Chairperson of the Advisory Committee



**CERTIFICATE FOR HAVING CARRIED OUT THE SUGGESTIONS OF THE EXTERNAL  
EXAMINER AND ADVISORY COMMITTEE**

Certified that Mr./ Ms. ----- Reg. No. -----has carried out all the corrections and suggestions as pointed out by the External examiner and the Advisory Committee. He / She has submitted **TWO** copies of his/ M.Sc. (Ag.). /(Hort.)/Agri Business Management thesis in hard bound cover and two soft copies in CD format, two copies each of the abstract of thesis and summary of the findings both in Tamil and English in CD format.

Professor and Head

Chairperson



**DEPARTMENT OF HORTICULTURE  
FACULTY OF AGRICULTURE**

---

Date:

**CERTIFICATE**

This is to certify that the thesis entitled "-----" submitted in partial fulfillment of the requirements for the award of the degree of ----- to Annamalai University, Annamalainagar is a record of bonafide research work carried out by ----, under my guidance and supervision and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has been published / not been published in part or full in any scientific or popular journals or magazines.

Chairman

1. Chairman :
2. Member :
3. Member :
4. External examiner:

### Distribution Pattern of Courses and Credit (M.Sc. (Hort.) in Vegetable Sciences)

Course Code	Course Title	Credit Hours
VSC 501*	Production of Cool Season Vegetable Crops	2+1
VSC 502*	Production of Warm Season Vegetable Crops	2+1
VSC 503*	Growth and Development of Vegetable Crops	2+1
VSC 504*	Principles of Vegetable Breeding	2+1
VSC 505	Breeding of Self-Pollinated Vegetable Crops	2+1
VSC 506	Breeding of Cross-Pollinated Vegetable Crops	2+1
VSC 507	Protected Cultivation of Vegetable Crops	1+1
VSC 508	Seed Production of Vegetable Crops	2+1
VSC 509	Production of Underutilized Vegetable Crops	2+1
VSC 510	Systematics of Vegetable Crops	1+1
VSC 511	Organic Vegetable Production	1+1
VSC 512	Production of Spice Crops	2+1
VSC 513	Processing of Vegetable	1+1
VSC 514	Postharvest Management of Vegetable Crops	2+1
	<b>Minor Courses</b>	08
	<b>Supporting Courses</b>	06
	<b>Common compulsory courses</b>	05
VSC 591	Seminar	0+1
VSC 599	Research	30
	<b>Total Credits</b>	<b>70</b>

\*Compulsory courses

## VSC 501 PRODUCTION OF COOL SEASON VEGETABLE CROPS (2+1)

### Learning objective

1. To impart knowledge about the scope, importance, area, production and constraints in warm season vegetable cultivation.
2. To learn about the commercial varieties and hybrids in warm season vegetable crops.
3. To acquire knowledge and skill on the advancement in production technology of warm season vegetable crops.
4. To gain knowledge about the harvesting and post-harvest management practices in warm season vegetable crops.
5. To impart knowledge on special horticultural practices like hydroponics, aeroponics and other soilless culture.

### Theory

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

### Unit I: Bulb and Tuber Crops

Onion, Garlic and Potato

### Unit II: Cole crops

Cabbage, cauliflower, kohlrabi, broccoli, brussels sprout and kale

### Unit III: Root crops

Carrot, radish, turnip and beetroot

### Unit IV: Peas and Beans

Garden peas, broad beans and french bean

### Unit V: Green leafy vegetables

Lettuce and Beet leaf

### Practical

Scientific raising of nursery and seed treatment/ sowing and transplanting/ description of commercial varieties and hybrids/ demonstration on methods of irrigation/ fertilizers and micronutrients application/ mulching practices, weed management/ use of plant growth substances in cool season vegetable crops/ nutritional and physiological disorders/ hydroponics, aeroponics and other soil less culture/ pest and diseases and their control/ preparation of cropping scheme for commercial farms/ visit to commercial farm, greenhouse/ polyhouses/ visit to vegetable market/ analysis of benefit cost ratio.

## Lesson plan

1. Introduction, commercial and nutritional importance of cool season vegetable crops.
2. Area, production, productivity and constraints in the cultivation of cool season vegetable crops.

Origin and distribution, botany and taxonomy, soil and climate requirements, commercial varieties seed rate, seed treatment, planting time and methods, cropping system, nutritional (including micronutrients) and irrigation requirements, intercultural operations, weed management, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of the following crops.

3. Onion
4. Onion
5. Garlic
6. Garlic
7. Potato
8. Potato
9. Potato
10. Cabbage
11. Cabbage
12. Cauliflower
13. Cauliflower
14. Kohlrabi
15. Kohlrabi
16. Broccoli
17. Broccoli
18. **Mid semester examination**
19. Brussels sprout
20. Kale
21. Carrot
22. Carrot
23. Radish
24. Radish
25. Turnip
26. Beet root
27. Beet root
28. Garden peas
29. Garden peas
30. Broad bean
31. French bean
32. French bean
33. Lettuce

### 34. Beet leaf

#### Practical

1. Scientific raising of nursery and seed treatment, sowing and transplanting
2. Description of commercial varieties and hybrids of cole crops
3. Description of commercial varieties and hybrids of bulb crops
4. Description of commercial varieties and hybrids of tuber crops
5. Description of commercial varieties and hybrids of root crops
6. Description of commercial varieties and hybrids of peas and beans crops
7. Description of commercial varieties and hybrids of leafy vegetable crops
8. Demonstration on methods of irrigation, fertilizers and micro nutrients application
9. Mulching practices and weed management
10. Use of plant growth substances in cool season vegetable crops
11. Study of nutritional and physiological disorders
12. Studies on hydroponics, aeroponics, and other soilless culture
13. Identification of important pest and diseases and their control
14. Preparation of cropping scheme for commercial farms
15. Visit to commercial farm, greenhouse/polyhouses and vegetable market
16. Analysis of benefit cost ratio

#### Final practical examination

#### Course outcome:

**CO 1:** Appreciate the scope and scenario of warm season vegetable crops in India

**CO 2:** Acquire knowledge and skill about the advancement in the production technology of warm season vegetable crops

**CO 3:** To gain comprehensive knowledge about the maturity indices, yield, post-harvest management practices in warm season vegetable crops.

**CO 4:** To understand about pest and disease management in warm season vegetable crop.

**CO 5:** To gain skill in working out cost economics of warm season vegetable crops.

#### CO - PO MAPPING MATIRX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	-	-	1	-
CO 2	3	1	2	2	-
CO 3	3	-	2	2	1
CO 4	2	1	-	1	-
CO 5	2	1	1	2	1

#### Suggested readings

1. Bose, T.K., Kabir, J., Maity, T.K., Parthasarathy, V.A. and Som, M.G., 2003. Vegetable crops. Vols. I-III. Nayaudyog.
2. Bose, T.K., Som, M.G. and Kabir, J. (Eds.). 1993. Vegetable crops. Nayaprokash.

3. Chadha, K.L. and Kalloo, G. (Eds.), 1993-94. Advances in horticulture Vols. V-X. Malhotrapubl. house.
4. Chadha, K.L. (Ed.), 2002. Hand book of horticulture. ICAR.
5. Fageria, M.S., Choudhary, B.R. and Dhaka, R.S., 2000, Vegetable crops: production technology. Vol. II. Kalyani publishers.
6. Gopalakrishanan, T.R., 2007, Vegetable crops. New India publ. agency.
7. Hazra, P. and Banerjee M.K. and Chattopadhyay, A., 2012, Varieties of vegetable crops in India, (Second edition), Kalyani publishers, Ludhiana, 199 p
8. Hazra, P., 2016, Vegetable science. 2<sup>nd</sup> edn, Kalyani publishers, Ludhiana.
9. Hazra, P., 2019, Vegetable production and technology. New India publishing agency, New Delhi.
10. Hazra, P., Chattopadhyay, A., Karmakar K. and Dutta, S., 2011, Modern technology for vegetable production, New India publishing agency, New Delhi, 413p
11. Rana, M.K., 2008, Scientific cultivation of vegetables. Kalyani publ.
12. Rana, M.K., 2014, Technology for vegetable production. Kalyani publishers, New Delhi.

#### **Suggested website**

1. <https://icar.org.in>
2. <https://btccarsbilaspur.com>
3. <http://www.hillagri.ac.in>
4. <https://www.ext.vsu.edu.in>
5. <https://agrimoon.com>

#### **VSC 502. PRODUCTION OF WARM SEASON VEGETABLE CROPS (2+1)**

#### **Learning objective**

1. To impart knowledge about the scope, importance, area, production and constraints in warm season vegetable cultivation.
2. To learn about the commercial varieties and hybrids in warm season vegetable crops.
3. To acquire knowledge and skill on the advancement in production technology of warm season vegetable crops.
4. To gain knowledge about the harvesting and post-harvest management practices in warm season vegetable crops.
5. To impart knowledge on special horticultural practices like hydroponics, aeroponics and other soilless culture

#### **Theory**

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

**Unit I** Fruit vegetables- Tomato, brinjal, hot pepper, sweet pepper and okra

**Unit II** Beans- French bean, Indian bean (Sem), cluster bean and vegetable cowpea

**Unit III** Cucurbits- Cucumber, melons, gourds, pumpkin and squashes

**Unit IV** Tuber crops- sweet potato, elephant foot yam, tapioca, taro and yam

**Unit V** Leafy vegetables- Amaranth, drumstick, coriander and fenugreek

### **Practicals**

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

### **Lesson plan**

1. Introduction, commercial, nutritional importance and export opportunity of warm season vegetable crops
2. Area, production, productivity and constraints of warm season vegetable crops  
Origin and distribution, botany and taxonomy, soil and climate requirements, commercial varieties/hybrids, seed rate and seed treatment, raising of nursery including grafting technique, sowing/planting time, precision farming, cropping system, nutritional (including micronutrients) and irrigation requirements, intercultural operations, special horticultural practices, hydroponics, aeroponics, weed management, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and economics.
3. Tomato
4. Tomato
5. Brinjal
6. Brinjal
7. Hot pepper
8. Sweet pepper
9. Okra
10. French bean
11. French bean
12. Indian bean
13. Cluster bean
14. Vegetable cowpea
15. Cucumber
16. Melons
17. **Mid semester examination**
18. Gourds



19. Gourds
20. Pumpkin
21. Squashes
22. Squashes
23. Sweet potato
24. Sweet potato
25. Elephant foot yam
26. Tapioca
27. Tapioca
28. Taro
29. Amaranth
30. Amaranth
31. Drumstick
32. Drumstick
33. Coriander
34. Fenugreek

### **Practical**

1. Scientific raising of nursery and seed treatment, sowing and transplanting,
2. Vegetable grafting
3. Description of commercial varieties and hybrids of fruit vegetables
4. Description of commercial varieties of beans
5. Description of commercial varieties and hybrids of cucurbits
6. Description of commercial varieties and hybrids of tuber crops
7. Description of commercial varieties of leafy vegetables
8. Demonstration on methods of irrigation, fertilizers and micronutrients application
9. Mulching practices and weed management
10. Use of plant growth substances in warm season vegetable crops
11. Study of nutritional and physiological disorders
12. Studies on hydroponics, aeroponics and other soilless culture
13. Identification of important pest and diseases and their control
14. Preparation of cropping scheme for commercial farms
15. Visit to commercial farm, greenhouse/polyhouses and vegetable market
16. Analysis of benefit to cost ratio
17. Final practical examination

### **Course Outcome:**

**CO 1:** Appreciate the scope and scenario of warm season vegetable crops in India

**CO 2:** Acquire knowledge and skill about the advancement in the production technology of warm season vegetable crops

**CO 3:** To gain comprehensive knowledge about the maturity indices, yield, post-harvest

management practices in warm season vegetable crops.

**CO 4:** To understand about pest and disease management in warm season vegetable crop.

1. To gain skill in working out cost economics of warm season vegetable crops.

**CO- PO MAPPING MATIRX:**

	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>
<b>CO 1</b>	<b>2</b>	-	-	<b>1</b>	-
<b>CO 2</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	-
<b>CO 3</b>	<b>2</b>	-	<b>1</b>	<b>1</b>	-
<b>CO 4</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>1</b>
<b>CO 5</b>	<b>2</b>	-	<b>1</b>	<b>1</b>	-

**Suggested Readings**

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Development. Research Periodicals & Book Publ. House.

### **Suggested Websites**

<https://blog-yard-garden-news.extension.umn.edu>

<https://agritech.tnau.ac.in>

<https://icar.org.in>

<https://www.bejo.com> ›

<http://agropedia.iitk.ac.in>

## **VSC 503 GROWTH AND DEVELOPMENT OF VEGETABLE CROPS (2+1)**

### **Learning Objectives**

- It is aimed to impart knowledge on physiology of growth and development.
- To study the role of essential nutrients in plant growth and development.
- To learn the role played by plant growth regulator in the growth and development process of vegetable crops
- To learn about the physiology of fruit set, fruit development, fruit growth, fruit drop and fruit ripening.
- To understand tissue culture techniques and grafting techniques in vegetable crops.

### **Theory**

#### **Unit I Introduction and Phytohormones**

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

#### **Unit II Physiology of dormancy and germination**

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

#### **Unit III Abiotic factors**

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

#### **Unit IV Fruit physiology**

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

#### **Unit V Morphogenesis and tissue culture**

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

### **Practical**

Understanding dormancy mechanism – stratification – growth regulator functions – hormone assays – ripening phenomenon in fruits and vegetables – preparation of solutions of plant growth substances and their application – experiments in breaking and induction of dormancy

by chemicals— evaluation of photosynthetic efficiency under different environments – induction of parthenocarpy and fruit ripening— application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables— growth analysis techniques in vegetable crops – impact of physical manipulations on growth and development – chemical manipulations on growth and development.

### **Lesson plan**

1. Cellular structures and their functions
2. Definition of growth and development, components, photosynthetic productivity
3. Leaf area index (LAI), optimum LAI in vegetable crops
4. Different stages of growth and its importance in vegetable production
5. Canopy development
6. Different stages of growth, growth curves, growth analysis in horticultural crops
7. Physiology of dormancy and germination of vegetable seeds, tubers and bulbs
8. Role of auxins in vegetable crops
9. Role of gibberellins in vegetable crops
10. Role of cytokinins and abscissic acid in vegetable crops
11. Role of growth regulators in propagation
12. Role of growth regulators in flowering
13. Role of growth regulators in fruit setting and fruit development
14. Role of growth regulators in fruit drop and fruit thinning
15. Role of growth regulators in fruit ripening
16. Application of synthetic hormones in vegetable crops
17. Mid semester examination
18. Application of synthetic hormones in vegetable crops
19. Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production
20. Role of light on growth and development of vegetable crops
21. Role of temperature on growth and development of vegetable crops
22. Role of photoperiod on growth and development of vegetable crops
23. Flowering and sex expression in vegetable crops
24. Apical dominance
25. Physiology of fruit set, fruit development, fruit growth
26. Physiology of flower and fruit drop
27. Parthenocarpy in vegetable crops

28. Phototropism in vegetable crops
29. Role of ethylene inhibitors, senescence and abscission
30. Fruit ripening and physiological changes associated with ripening
31. Physiological changes associated with senescence
32. Plant growth regulators in relation to vegetable production
33. Plant growth regulators in relation to morphogenesis
34. Plant growth regulators in relation to tissue culture techniques in vegetable crops.

### **Practical**

1. Understanding dormancy mechanisms in seeds, tubers and bulbs
2. Stratification of seeds, tubers and bulbs
3. Study of growth regulator functions
4. Hormone assays
5. Preparation of plant growth regulator's solutions and their application
6. Experiments in breaking and induction of dormancy by chemicals
7. Experiments in induction of parthenocarpy
8. Experiments in fruit ripening
9. Application of plant growth substances for improving flower initiation
10. Application of plant growth substances in changing sex expression in cucurbits
11. Application of plant growth substances for checking flower and fruit drops and improving fruit set in solanaceous vegetables
12. Growth analysis techniques in vegetable crops
13. Grafting techniques into mato, brinjal, cucumber and sweet pepper.
14. Evaluation of photosynthetic efficiency under different environments
15. Study of impact of physical manipulations on growth and development
16. Study of chemical manipulations on growth and development
17. Orientation for practical examination

### **Course Outcome**

CO 1: Acquire knowledge about the growth and development of plants in vegetable crops.

CO 2: Distinguish between primary and secondary growth in plant stems.

CO 3: Understand how hormones affect the growth and development of vegetable crops.

CO 4: Understand the impact of abiotic factors on growth, development, flowering and sex expression in vegetables.

CO 5: Gain knowledge about the physiology of dormancy and germination of vegetable seeds. Tubers and bulbs.

## CO-PO MAPPING MATIRX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO-1	1	1	-	-	-
CO-2	1	1	-	1	-
CO-3	2	-	1	2	-
CO-4	2	2	1	2	1
CO-5	1	1	1	-	-

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### SUGGESTED WEBSITES

1. <http://agritech.tnau.ac.in>
2. <http://www.avrdc.org/index.php?id=143>
3. <http://www.vigyanprasar.gov.in/comcom/develop62.htm>
4. <http://www.aushs.org.au/>
5. <http://www.cgiar.org/>

## VSC 504 PRINCIPLES OF VEGETABLE BREEDING (2+1)

### Learning objective

1. Acquire knowledge about the importance, history and evolutionary aspects of vegetable breeding.
2. To gain knowledge about principles, selection procedures and hybridization of vegetables crops.
3. Understand the breeding mechanism for biotic and abiotic stress and quality improvement.
4. To acquire comprehensive knowledge about breeding of asexually propagated vegetable crops.
5. To know about the applications of in vitro and molecular techniques in vegetable improvement.

### Theory

#### Unit I

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

#### Unit II

*Selection procedures*- Techniques of selfing and crossing; Breeding systems and methods; Selection procedures and hybridization; Genetic architecture; Breeding for biotic stress (diseases, insect pests and nematode), abiotic stress (temperature, moisture and salt) resistance and quality improvement; Breeding for water use efficiency (WUE) and nutrients use efficiency(NUE)

#### Unit III

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

#### Unit IV

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

#### Unit V

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

### Practicals

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

### Lesson plan

- 1 Objectives and scope of vegetable breeding – modes of reproduction
- 2 Mechanisms of pollination control
- 3 Study of self-incompatibility

- 4 Genetic resources- Importance - germplasm - centre of origin -Mega and microgene Centres
- 5 Exploitation of wild relatives in vegetable breeding and wild hybridization
- 6 Genetic divergence in vegetable crops
- 7 Mechanism for promotion of self and cross pollination
- 8 Male sterility
- 9 Study of sex forms - cucurbits and asparagus
- 10 Methods of breeding -Introduction, selection and hybridization in autogamous crops
- 11 Methods of breeding -Selection and hybridization in allogamous and asexually propagated Crops
- 12 Selection -Effect of selection in autogamous crops
- 13 Selection -Effect of selection in allogamous and asexually propagated crops
- 14 Hybridisation techniques for artificial hybridization
- 15 Genotypic frequencies of population, genetic load and genetic drift
- 16 Wide hybridization
- 17 Mid semester examination**
18. Mutation breeding - techniques, physical and chemical mutagens
19. Polyploidy breeding
20. Heterosis - mechanisms and basis - types of heterotic hybrids and uses
21. Backcross method of breeding and trait introgression
22. Handling of filial generations of different vegetables
23. Inheritance of qualitative and quantitative traits
24. Breeding for biotic stress (diseases) resistance
25. Breeding for biotic stress (pest) resistance
26. Breeding for abiotic stress
27. Breeding for quality improvement
28. Breeding for nutrient and water use efficiency
29. Breeding of vegetables suitable for protected environment- tomato, cucumber, capsicum
30. Plant ideotype, concept, selection indices
31. Procedure for variety release
32. DUS testing in vegetable crops
33. Application of in-vitro techniques in vegetable improvement
34. Application of molecular techniques in vegetable improvement
27. Breeding for quality improvement



28. Breeding for nutrient and water use efficiency
29. Breeding of vegetables suitable for protected environment- tomato, cucumber, capsicum
30. Plant ideotype, concept, selection indices
31. Procedure for variety release
32. DUS testing in vegetable crops
33. Application of *in-vitro* techniques in vegetable improvement
34. Application of molecular techniques in vegetable improvement

### **Practical Schedule**

- 1 Study of pollination mechanism –emasculation, hybridization methods in solanaceous vegetables
- 2 Study of pollination mechanism – emasculation, hybridization methods in cucurbitaceous vegetables
- 3 Study of pollination mechanism –emasculation, hybridization methods in cole crops
- 4 Study of pollination mechanism –emasculation, hybridization methods in okra
- 5 Floral biology and pollination behaviour of vegetable crops I
- 6 Floral biology and pollination behaviour of vegetable crops II
- 7 Handling segregating population - F2 and F3
- 8 Handling segregating population–recombinant inbred lines
- 9 Assessing variability in natural and segregating population
- 10 Estimation of heritability and genetic advance
- 11 Different types of male sterility in role of heterosis breeding
- 12 Change in gene and genotypic frequencies
- 13 *in-situ* and *ex-situ* conservation and utilization of germplasm
- 14 Innovative breeding methods
- 15 Procedure for variety release
16. Visit to breeding farms/ gene bank and biotechnological lab
- 17 **Final practical examination**

#### **Course Outcome:**

- CO 1: Acquire knowledge about the principles of vegetable breeding.
- CO 2: Skill in performing selfing and crossing of different vegetable crops.
- CO 3: Gain comprehensive knowledge on improving yield, quality and breeding for biotic and abiotic stress in vegetable crops.
- CO 4: To understand the application of molecular markers in vegetable crop improvement.
- CO 5: Understand how the basic principles are important to start breeding of vegetable crops.

## CO PO- MAPPING MATIRX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO-1	1	2	1	2	1
CO-2	1	2	2	2	1
CO-3	1	3	2	2	1
CO-4	1	2	1	1	1
CO-5	1	2	1	1	1

### Suggested readings

Allard, R.W., 1960, Principle of plant breeding. John Willey and Sons, USA. Kalloo, G., 1988, Vegetable breeding (Vol. I, II, III). CRC Press, FL, USA.

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Paroda RS & Kalloo G. (Eds.). 1995. Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Region. FAO.

### **Suggested websites**

- 1 <https://annamalaiuniversity.ac.in>
- 2 <https://icar.org.in>
- 3 <https://agritech.tnau.ac.in>
- 4 <https://www.bejo.com> ›
- 5 <https://www.coabnau.in>

## **VSC 505. BREEDING OF SELF-POLLINATED VEGETABLE CROPS (2+1)**

### **Learning objective**

1. To educate the principles and practices of breeding of self-pollinated vegetable crops.
2. To impart comprehensive knowledge about various methods of breeding of self-pollinated veg. crops.
3. To learn about the details of varieties released in the self-pollinated vegetable crops.
4. To gain knowledge about the resistance breeding for biotic and abiotic stress and quality improvement in self-pollinated vegetable crops.
5. Understand the role of molecular markers and marker assisted breeding in self-pollinated vegetable crops.

### **Theory**

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

### **Unit I**

Tuber crops: Potato

### **Unit II**

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

### **Unit III**

Leguminous vegetables- Garden peas and cowpea

### **Unit IV**

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

### **Unit V**

Leafy vegetables- Lettuce and fenugreek

### **Practicals**

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

## Lesson plan

- 1 Breeding in self-pollinated vegetable crops for quantitative traits
- 2 Breeding in self-pollinated vegetable crops for qualitative traits
- 3 Breeding in self-pollinated vegetable crops for protected environment
- 4 Resistance breeding for biotic and abiotic stresses in vegetable crops
- 5 Potato-Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization, mutation genetic transformation)
- 6 Potato - Varieties and varietal characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
- 7 Tomato - Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization, mutation, genetic transformation)
- 8 Tomato- Varieties/ hybrids characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
- 9 Egg plant- Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization and mutation)
- 10 Egg plant- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
- 11 Chilli-Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization)
- 12 Chilli- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
- 13 Sweet pepper- Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization)
- 14 Sweet pepper- Varieties/ hybrids characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
- 15 Okra - Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction,selection, hybridization, mutation)
- 16 Okra - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs

## 17 Mid semester examination

18. Peas- Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization, mutation)
19. Peas - Varieties characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
20. Cowpea- Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization)
21. Cowpea- Varieties characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
22. French bean- Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization, mutation)
23. French bean- Varieties characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
24. Indian bean- Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy)
25. Indian bean- Varieties characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
26. Cluster bean- Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization)
27. Cluster bean- Varieties characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
28. Broad bean- Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization)
29. Broad bean- Varieties characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
30. Lettuce- Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization)
31. Lettuce- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
32. Fenugreek- Origin, botany, taxonomy, wild relatives, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization), varieties / hybrids characterization, resistance breeding for biotic and abiotic stresses and quality improvement, molecular markers and marker's assisted breeding; QTLs
33. PPV & FRA in vegetable crops
34. Hybrid seed production in self pollinated vegetable crops

## **Practical**

- 1 Floral mechanisms favour in self pollination
- 2 Floral mechanisms favour in often cross pollination
- 3 Progeny testing and development of purelines
- 4 Selection of desirable plants from breeding population, observations and analysis of various quantitative traits in germplasm, hybrids and segregating generations
- 5 Selection of desirable plants from breeding population, observations and analysis of various qualitative traits in germplasm, hybrids and segregating generations
- 6 Palonological studies
- 7 Selfing techniques
- 8 Crossing techniques
- 9 Commercial seed production of self-pollination vegetable crops
- 10 Screening techniques for biotic and abiotic stress resistance in tomato
- 11 Screening techniques for biotic and abiotic stress resistance in egg plant
- 12 Screening techniques for biotic and abiotic stress resistance in hot pepper
- 13 Screening techniques for biotic and abiotic stress resistance in okra
- 14 Screening techniques for biotic and abiotic stress resistance in Leguminaceae crops
- 15 Molecular marker techniques to identify useful traits
16. Visit to breeding farms
- 17 **Final Practical Examination**

### **Course Outcome:**

**CO 1:** Acquire knowledge about floral mechanism favoring self-pollination in vegetable crops.

**CO 2:** To understand the specific breeding methods commonly adopted for self-pollinated vegetable crops.

**CO 3:** Gain knowledge about the varieties and hybrids released in self -pollinated vegetable crops.

**CO 4:** Understand the methods of improving the yield and quality of vegetable crops.

**CO 5:** Understand how to start the breeding of self-pollinated vegetable crops.

## CO PO MAPPING MATIRX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO-1	-	3	1	1	-
CO-2	-	3	2	2	1
CO-3	-	2	1	1	2
CO-4	-	3	1	1	1
CO-5	-	2	1	1	1

### Suggested readings

- 1 Allard, R.W., 1999, Principles of plant breeding. John Wiley and
- 2 Dhillon, B.S., Tyagi, R.K., Saxena, S. and Randhawa, G.J., 2005, Plant genetic resources: horticultural crops. Narosa Publ. House.
- 3 Fageria, M.S., Arya, P.S. and Choudhary, A.K., 2000, Vegetable crops: Breeding and Seed production. Vol. I. Kalyani.
- 4 Hazra, P. and Som, M.G., 2015, Vegetable science (Second revised edition), Kalyani publishers, Ludhiana, 598 p
- 5 Hazra, P. and Som, M.G., 2016, Vegetable seed production and hybrid technology(Second revised edition), Kalyani Publishers, Ludhiana, 459 p
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- 8 Peter, K.V. and Pradeep kumar, T., 2008, Genetics and breeding of vegetables. Revised, ICAR.
- 9 Peter, K.V. and Hazra, P. (Eds), 2012,Hand book of vegetables. Studium press LLC, P.O. Box722200, Houston, Texas 77072, USA, 678p
- 10 Peter, K.V. and Hazra, P. (Eds), 2015,Hand book of vegetables Volume II. Studium, PressLLC, P.O. Box 722200, Houston, Texas 77072, USA, 509 p.
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- 12 Rai, N. and Rai, M., 2006, Heterosis breeding in vegetable crops. New India Publ. Agency.
- 13 Simmonds, N.W., 1978, Principles of crop improvement. Longman. Singh BD. 1983. Plant Breeding. Kalyani Publ.
- 14 Singh,P.K., Dasgupta, S.K. and Tripathi, S.K., 2004, Hybrid vegetable development. International Book Distributing Co.
- 15 Swarup, V., 1976, Breeding procedure for cross-pollinated vegetable crops. ICAR.

16 Hari Har Ram, 1997. Vegetable breeding: Principles and Practices. Kalyani Publishers.

### **Suggested websites**

- 1 <https://icar.org.in>
- 2 <https://agritech.tnau.ac.in>
- 3 <https://agriinfo.in> ›
- 4 <https://annamalaiuniversity.ac.in>
- 5 <https://www.researchgate.net> ›

### **VSC 506. BREEDING OF CROSS-POLLINATED VEGETABLE CROPS (2+1)**

#### **Learning objective**

1. To acquire knowledge about botany, taxonomy, cytogenetics, genetics, pollination and floral mechanism of cross-pollinated vegetables.
2. To educate breeding objectives and methods employed for the production of cross-pollinated vegetable crops.
3. To gain comprehensive knowledge about improving yield, quality, abiotic and biotic resistance in cross pollinated crops.
4. To understand about molecular markers and marker assisted breeding in cross pollinated vegetable crops.
5. Acquire knowledge about the breeding of cross-pollinated vegetable crops.

#### **Theory**

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

#### **Unit I**

Cucurbitaceous crops- Gourds, melons, cucumber, pumpkin and squashes

#### **Unit II**

Cole crops- Cauliflower, cabbage, kohlrabi, broccoli and brussels sprouts

#### **Unit III**

Root and bulb crops- Carrot, radish, turnip, beet root and onion

#### **Unit IV**

Tuber crops- Sweet potato, tapioca, taro and yam

#### **Unit V**

Leafy vegetables- Beet leaf, spinach, amaranth and coriander

#### **Practicals**

Floral mechanisms favouring cross pollination/ Development of inbred lines/ Selection of desirable plants from breeding population/ Observations and analysis of various quantitative and qualitative traits in germplasm, hybrids and segregating generations/ Induction of flowering, palyno logical studies, selfing and crossing techniques/ Hybrid seed production of vegetable crops in bulk; Screening techniques for biotic and abiotic stress resistance in above mentioned crops/ Demonstration of sib-mating and mixed



population/ Molecular marker techniques to identify useful traits in vegetable crops and special breeding techniques/ Visit to breeding blocks

### **Lesson plan**

- 1 Snake gourd- Origin, botany and taxonomy, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
- 2 Bitter gourd- Origin, botany and taxonomy, cytogenetics, pollination mechanism, incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
- 3 Bottle gourd- Origin, botany and taxonomy, cytogenetics, breeding objectives, breeding methods (introduction, selection, hybridization) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
- 4 Ridge gourd- Origin, botany and taxonomy, cytogenetics, breeding objectives, breeding methods (introduction, selection, hybridization) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
- 5 Cucumber- Origin, botany and taxonomy, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
- 6 Pumpkin and ash gourd- Origin, botany and taxonomy, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
- 7 Watermelon and muskmelon- Origin, botany and taxonomy, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization)- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
- 8 Summer squash and winter squash- Origin, botany and taxonomy, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization)- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
- 9 Cabbage- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization)
- 10 Cabbage- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs

- 11 Cauliflower- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization)
- 12 Cauliflower- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
- 13 Broccoli- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation)- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted Breeding
- 14 Brussel sprout- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation) - varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding
- 15 Kohlrabi-Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation, polyploidy)- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding
- 16 Carrot- Origin, botany and taxonomy, pollination mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization),varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding
- 17 **Mid semester examination**
- 18.Radish- Origin, botany and taxonomy, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection, hybridization), varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement molecular markers and marker assisted breeding
- 19.Turnip- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding
- 20.Beetroot- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, hybridization) -Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding
- 21.Aggregatum onion- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, double haploidy) , Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding

and QTLs

22. Common onion- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, double haploidy) , Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
23. Moringa- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
24. Moringa- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
25. Sweet potato- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility, breeding objectives, breeding methods (introduction, selection) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
26. Tapioca- Origin, botany and taxonomy, cytogenetics, pollination mechanism, incompatibility, breeding objectives, breeding methods (introduction, selection, mutation) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
27. Tapioca- Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
28. Taro - Origin, botany and taxonomy, pollination mechanism, incompatibility, breeding objectives, breeding methods (introduction, selection, mutation) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
29. Yam- Origin, botany and taxonomy, pollination mechanism, incompatibility, breeding objectives, breeding methods (introduction, selection, mutation) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
30. Beet leaf - Origin, botany and taxonomy, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection) Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding
31. Spinach- Origin, botany and taxonomy, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs
32. Amaranth- Origin, botany and taxonomy, cytogenetics, pollination mechanism, breeding objectives, breeding methods (introduction, selection) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs

33. Coriander- Origin, botany and taxonomy, cytogenetics, pollination mechanism, sterility and incompatibility, breeding objectives, breeding methods (introduction, selection, mutation, polyploidy) - Varieties /hybrids characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding and QTLs

34. PPV & FRA in cross pollinated vegetable crops

### **Practical**

- 1 Floral mechanisms favouring cross pollination
- 2 Development of inbred lines
- 3 Selection of desirable plants from breeding population
- 4 Observations and analysis of various quantitative traits in germplasm, hybrids and segregating generations
- 5 Observations and analysis of various qualitative traits in germplasm and hybrids
- 6 Observations and analysis of various qualitative traits in segregating generations
- 7 Palonological studies
- 8 Selfing and crossing techniques
- 9 Commercial seed production of vegetable crops
- 10 Maintenance of parental lines
- 11 Screening techniques for biotic stress resistance in cross pollinated crops
- 12 Screening techniques for abiotic stress resistance in cross pollinated crops
- 13 Demonstration of sib-mating and mixed population
- 14 Molecular marker techniques to identify useful traits in vegetable crops
- 15 Special breeding techniques- Haploidy, double haploidy and speed breeding
- 16 Visit to breeding farms/ seed production units
- 17 **Final practical examination**

### **Course Outcome:**

**CO 1:** acquire knowledge about the breeding of cross-pollinated vegetable crops.

**CO 2:** gain comprehensive knowledge about production of biotic and abiotic stress resistance in cross pollinated vegetable crops.

**CO 3:** improve the yield and quality of cross-pollinated vegetable crops.

**CO 4:** understand the molecular marker techniques to identify useful traits in vegetable crops.

**CO 5:** understand how to start the breeding of cross-pollinated vegetable crops.

### CO PO- MAPPING MATIRX:

	PO 1	PO 2	PO 3	PO 4	PO 5
CO-1	1	2	1	2	-
CO-2	1	3	2	2	-
CO-3	1	3	1	2	-
CO-4	1	3	2	2	1
CO-5	1	3	2	2	1

#### Suggested readings

- 1 Allard, R.W., 1999, Principles of plant breeding. John Wiley and Sons. Basset, M.J. (Ed.), 1986, Breeding vegetable crops. AVI Publ.
- 2 Dhillon, B.S., Tyagi, R.K., Saxena, S. and Randhawa, G.J., 2005, Plant genetic resources: horticultural crops. Narosa publ. house.
- 3 Fageria, M.S., Arya, P.S. and Choudhary, A.K., 2000, Vegetable crops: breeding and seed production. Vol. I. Kalyani.
- 4 Gardner, E.J., 1975, Principles of genetics. John Wiley and Sons.
- 5 Hayes, H.K., Immer, F.R. and Smith, D.C., 1955, Methods of plant breeding. McGraw-Hill.
- 6 Hayward, M.D., Bosemark, N.O. and Romagosa, I. (Eds.), 1993, Plant breeding-principles and prospects. Chapman and Hall.
- 7 Hazra, P. and Som M.G., 2015, Vegetable science (Second revised edition), Kalyani publishers, Ludhiana, 598 p
- 8 Hazra, P. and Som, M.G., 2016, Vegetable seed production and hybrid technology(Second revised edition), Kalyani Publishers, Ludhiana, 459 p
- 9 Kalloo, G., 1988, Vegetable breeding. Vols. I-III. CRC Press.
- 10 Kalloo, G., 1998, Vegetable breeding. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
- 11 Kumar, J.C. and Dhaliwal, M.S., 1990, Techniques of developing hybrids in vegetable crops. Agro botanical publ.
- 12 Paroda, R.S. and Kalloo, G. (Eds.), 1995, Vegetable research with special reference to hybrid technology in Asia-Pacific region. FAO.

#### Suggested websites

- 1 <https://agris.fao.org>
- 2 <https://icar.org.in>
- 3 <https://agritech.tnau.ac.in>
- 4 <https://www.rvskvv.net> › images › II-Y
- 5 <https://extension.uga.edu> ›

## VSC 507- PROTECTED CULTIVATION OF VEGETABLE CROPS (1+1)

### Learning Objective:

1. To gain knowledge on the concept, scope, importance, principles and design of polyhouses.
2. Need to have an understanding about classification types and construction of protected structures.
3. To improve latest technology about manipulation of environmental factors on crop production in vegetable crops.
4. To gain understanding about high-tech vegetables nursery raising under protected structures.
5. To impart technology of cultivating vegetable crops and its seed production, under protected structures economics of greenhouse crop production.

### Theory

#### Unit I

*Scope and importance-* Concept, scope and importance of protected cultivation of vegetable crops; Principles, design, orientation of structure, low and high cost polyhouses/ greenhouse structures.

#### Unit II

*Types of protected structure-* Classification and types of protected structures greenhouse/polyhouses, plastic-non plastic low tunnels, plastic walk in tunnels, high roof tunnels with ventilation, insect proof net houses, shed net houses, rainshelters, NVP, climate control greenhouses, hydroponics and aeroponics; Soil and soilless media for bed preparation; Design and installation of drip irrigation and fertigation system.

#### Unit III

Abiotic factors- Effect of environmental factors and manipulation of temperature, light, carbon dioxide, humidity, etc. on growth and yield of different vegetables.

#### Unit IV

Nursery raising and crop cultivation- High tech vegetable nursery raising in protected structures using plugs and portrays, different media for growing nursery under protected cultivation; Nursery problems and management technologies including fertigation- Regulation of flowering and fruiting in vegetable crops; Technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, including varieties and hybrids, training, pruning and staking in growing vegetables under protected structures.

#### Unit V

Solutions to problems- Problems of growing vegetables in protected structures and their remedies, physiological disorders, insect and disease management in protected structures; Use of protected structures for seed production; Economics of greenhouse crop production.

### Lesson plan

13. Concept, scope and importance of protected cultivation of vegetable crops
14. Principles, design, orientation of green house structure
15. Low cost polyhouses/ greenhouse structures.
16. High cost poly house /green house structures
17. Classification of protected structures- greenhouse/ polyhouses.
18. Types of protected structures- greenhouse/ polyhouses
19. Plastic-non plastic low tunnels, plastic walk in tunnels,
20. High roof tunnels with ventilation

21. Insect proof net houses,
22. Shed net houses,
23. Rain shelters, NVP,
24. Climate control greenhouses
25. Hydroponics and aeroponics
26. Soil for bed preparation
27. Types of media for bed preparation
28. Design and installation of drip irrigation
29. **Mid-semester examination**
30. Fertigation system of green house
31. Effect of environmental factors and manipulation of temperature and light on growth and yield of different vegetables.
32. Effect of environmental factors and manipulation of carbon dioxide and humidity on growth and yield of different vegetables
33. High tech vegetable nursery raising in protected structures using plugs and portrays
34. Different media for growing nursery under protected cultivation
35. Nursery problems and management technologies including fertigation.
36. Regulation of flowering and fruiting in vegetable crops;
37. Technology for raising tomato and other vegetables in protected structures, including varieties and hybrids, training, pruning and staking in growing vegetables under protected structures.
38. Technology of raising sweet pepper in protected structures.
39. Technology of raising cucumber in protected structures
40. Problems of growing vegetables in protected structures and their remedies.
41. Physiological disorders of vegetables in protected structures
42. Insect and disease management in protected structures
43. Use of protected structures for seed production of Tomato
44. Use of protected structures for seed production of Sweet pepper.
45. Use of protected structures for seed production of Cucumber.
46. Economics of green house cultivation.
- 47.

### **Practicals**

Study of various types of protected structure-Nursery management to raise quality seedlings for protected cultivation- study of soil sterilization in protected structures- Study of different methods to control temperature, carbon dioxide and light- Study of different types of growing media, training and pruning systems in greenhouse crops- Study of fertigation and nutrient management under protected structures- Study of insect pests and diseases in greenhouse and its control-Use of protected structures in hybrid seed production of vegetables- Economics of protected cultivation - Visit to established green/ polyhouses/ shade net houses in the region.

### **Practical**

1. Study of various types of protected structures
2. Nursery management to raise quality seedlings for protected cultivation
3. Study of soil sterilization in protected structures.
4. Methods to control temperature, humidity, CO<sub>2</sub> and light
5. Training, pruning and special horticultural practices in protected structures for tomato

6. Training, pruning and special horticultural practices in protected structures for capsicum
7. Training, pruning and special horticultural practices in protected structures for cucumber.
8. Study of fertigation and nutrient management under protected structures
9. Use of protected structures in hybrid seed production of vegetables.
10. Pest management in protected structures.
11. Disease management in protected structures.
13. Economics of protected cultivation of tomato , capsicum and cucumber
14. Economics of protected cultivation of capsicum and cucumber
15. Visit to established commercial protected vegetable cultivation units – tomato .
16. Visit to established commercial protected flower cultivation units – capsicum and cucumber.
17. **Final Practical Examination**

### Learning outcome

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

- CO 1: Appreciate the scope and scenario of protected cultivation of vegetable crops in India
- CO 2: Acquire knowledge about the effect of abiotic factors on growth, flowering and production of vegetable crops
- CO 3: Gaining knowledge about the designing of various low cost protected structures
- CO 4: Adopting the raising of vegetable seedlings in low cost protected structures as entrepreneur.
- CO 5: To impart latest knowledge about use of protected structures for seed production.

### CO PO- MAPPING MATIRX

	PO1	PO2	PO3	PO4	PO5
CO-1	3	1	1	2	1
CO-2	2	1	1	1	1
CO-3	3	1	2	2	1
CO-4	2	1	1	3	1
CO-5	2	1	1	1	1

### Suggested Reading

1. Chadha KL and Kalloo G. (Eds.). 1993-94. *Advances in horticulture*. Malhotra Pub. House.
2. Chandra S and Som V. 2000. *Cultivating vegetables in green house*. Indian horticulture 45:17-18.
3. Kalloo G and Singh K. (Eds.). 2000. *Emerging scenario in vegetable research and development*. Research periodicals and Book publ. house.
4. Parvatha RP. 2016. *Sustainable crop protection under protected cultivation*. E-Book Springer.
5. Prasad S and Kumar U. 2005. *Greenhouse management for horticultural crops*. 2nd Ed. Agrobios.
6. Resh HM. 2012. *Hydroponic food production*. 7th Edn. CRC Press.
7. Singh B. 2005. *Protected cultivation of vegetable crops*. Kalyani publishers, New Delhi
8. Singh DK and Peter KV. 2014. *Protected cultivation of horticultural crops* (1st Edition) New India publishing agency, New Delhi.
9. India publishing agency, New Delhi.
10. Singh S, Singh B and Sabir N. 2014. *Advances in protected cultivation*. New India publishing agency, New Delhi.



11. Tiwari GN. 2003. Green house technology for controlled environment. Narosa publ. house.

### **Suggested websites**

1. [www.krishi.icar.gov.in](http://www.krishi.icar.gov.in)
2. [www.phytojournal.com](http://www.phytojournal.com)
3. [www.ncert.nic.in](http://www.ncert.nic.in)
4. <http://www.academia.edu>
5. <http://ivtc.avrdc.org>

## **VSC 508 SEED PRODUCTION OF VEGETABLE CROPS (2+1)**

### **Learning Objective**

- Appreciate the scope, status and scenario of vegetable seed industry.
- To introduce the basic principles of quality seed production.
- To acquire knowledge about scientific production and maintenance and labeling of seeds.
- To impart comprehensive knowledge on seed harvesting, extraction and processing of seeds.
- To gain skill about seed production technology of vegetable crops with adequate practical training.

### **Theory**

#### **Unit I Introduction, history, propagation and reproduction**

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

#### **Unit II Agro-climate and methods of seed production**

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

#### **Unit III Seed multiplication and its quality maintenance**

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

#### **Unit IV – Seed harvesting, extraction and its processing –**

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

#### **Unit V – Improved agro-techniques and field and seed standards**

Improved agro-techniques; Field and seed standards in important solanaceous, leguminous and cucurbitaceous vegetables, cole crops, leafy vegetables, bulbous and root crops and okra; clonal propagation and multiplication in vegetative propagated crops; Seed plot technique and true potato seed production in potato

## Practicals

Identification of seeds –nursery management – floral biology – hybrid seed production techniques –planting design- identification of rogue and off type - supplementary pollination - physiological maturity- seed enhancement- seed extraction methods - visit to private seed farm – processing unit-seed industry–economics of seed production.

## Lesson plan

1. Introduction, definition of seed and its quality
2. Importance and characteristics of quality seed
3. Seed morphology, development and maturation
4. Apomixis and fertilization
5. Modes of propagation and reproductive behavior in vegetables
6. Pollination mechanisms and sex forms in vegetables
7. History of vegetable seed production; Status and share of vegetable seeds in seed industry
8. Agro-climate and its influence on quality seed production
9. Deterioration of crop varieties, genetical and agronomic principles of vegetable seed production
10. Methods of seed production
11. Methods of hybrid seed production
12. Techniques of large scale hybrid seed production
13. Seed village concept
14. Seed multiplication ratios and replacement rates in vegetables
15. Maintenance and production of nucleus, breeder, foundation, certified/ truthful label seeds
16. Seed quality and mechanisms of genetic purity testing
17. Mid semester examination
18. Maturity standards; Seed harvesting, curing and extraction
19. Seed processing, viz., cleaning, drying and treatment of seeds, seed health and quality enhancement
20. packaging and marketing
21. Principles of seed storage; Orthodox and recalcitrant seeds;
22. Seed dormancy
23. Seed production and Post-harvest technology for annual vegetables viz., tomato, brinjal, chillies.
24. Seed production and Post-harvest technology for cucurbitaceous vegetables.
25. Seed production and Post-harvest technology for lablab, cowpea.
26. Seed production and Post-harvest technology for bhendi.
27. Seed production and Post-harvest technology for biennial vegetables viz., cauliflower, cabbage, knoll-khol.

28. Seed production and Post-harvest technology for carrot, beetroot, turnip and radish.
29. Seed production and Post-harvest technology for annual leafy vegetables *viz.*, palak, amaranthus, spinach, lettuce.
30. Seed production and Post-harvest technology for onion
31. Seed production and Post-harvest technology for garlic.
32. Seed production and Post-harvest technology for sweet potato and colocasia.
33. Seed production and Post-harvest technology of potato,
34. Seed-plot technique in potato tuber seed production and TPS (true potato seed).

#### **Practical**

1. Identification of vegetable seeds.
2. Study on sowing and nursery management.
3. Study on transplanting and age of seedling on crop establishment.
4. Studying floral biology of solanaceous, malvaceous and cucurbitaceous vegetables
5. Studying floral biology of other vegetable crops.
6. Practicing planting design for hybrid seed production.
7. Modification of sex ratio in cucurbits.
8. Practicing emasculation and pollination methods.
9. Practicing roguing operations - identification of off-types - selfed fruits.
10. Harvesting methods - single and multiple harvesting method.
11. Practicing seed extraction methods - wet methods - tomato, brinjal, other cucurbitaceous fruits.
12. Seed extraction - dry methods - chillies, bhendi, cucurbitaceous vegetables.
13. Visit to seed production fields.
14. Visit to private seed industry.
15. Planning and economics of varietal seed production.
16. Planning and economics of hybrid seed production.
17. Orientation of practical examination.

#### **Course Outcome:**

**CO 1:** Appreciate the scope and scenario of seed production of vegetable crops in India

**CO 2:** Acquire knowledge on production of production of nucleus, breeder, foundation and certified truthfully labeled seeds.

**CO 3:** Gain comprehensive knowledge on seed harvesting, extraction and its processing.

**CO 4:** Gain knowledge on the clonal propagation and multiplication in vegetative propagated crops.

**CO 5:** Adoption of seed production of vegetable crops as entrepreneur.

### CO PO MAPPING MATIRX:

	PO 1	PO 2	PO 3	PO 4	PO 5
CO-1	2	1	-	1	-
CO-2	3	2	1	1	1
CO-3	2	1	1	1	1
CO-4	2	1	1	2	1
CO-5	3	2	2	2	1

### References

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### Suggested e-books

<https://www.springer.com/in/book/9780792373223>  
<http://203.64.245.61/fulltext-pdf/EB/1900-2000/eb0021.pdf>

<https://trove.nla.gov.au/work/6862691?q&sort=holdings+desc&-=1541066209257&versionId=45008917+251246346>

### Suggested websites

<https://agriinfo.in/botany/18/>  
[http://agritech.tnau.ac.in/seed\\_certification/seedtech\\_index.html](http://agritech.tnau.ac.in/seed_certification/seedtech_index.html)  
<http://www.yspuniversity.ac.in/vgc/caft/Compendium2017-18.pdf>  
<http://www.agrimoon.com/wp-content/uploads/Seed-Production-of-Vegetable.pdf>  
<http://ecoursesonline.iasri.res.in>

## VSC 509-PRODUCTION OF UNDERUTILIZED VEGETABLE CROPS (2+1)

### Learning objective

1. It helps to explore the possibilities of using newer indigenous plant resources.
2. The proper understanding of utilization of underutilized vegetable crops may help to contribute to food security, nutrition and health.
3. To gain knowledge about region specific, less available, less utilized or rarely used, minor, orphan, promising and little-used vegetable crops.
4. To gain knowledge about plant species adapted to extreme environmental conditions and threatened habitats, having genetic tolerance to survive under harsh conditions and possess qualities of nutritional importance.
5. To impart knowledge about production technology of lesser utilized vegetable crops.

### Theory

Importance and scope, botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting and yield, plant protection measures and Post-harvest management of:

#### Unit I

Stem and bulb crops – Asparagus, leek and chinese chive

#### Unit II

Cole and salad crops – Red cabbage, chinese cabbage, kale, sweet corn and baby corn

#### Unit III

Leafy vegetables – Celery, parsley, indian spinach (poi), spinach, chenopods, chekurmanis and indigenous vegetables of regional importance

#### Unit IV

Gourds and melons – Sweet gourd, spine gourd, teasle gourd, round gourd, and little/ Ivy gourd, snake gourd, pointed gourd, kachri, long melon, snap melon and gherkin

#### Unit V

Yam and beans – Elephant foot yam, yam, yam bean, lima bean and winged bean

### Lesson plan

Importance and scope, botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting and yield, plant protection measures and post-harvest management of:

1. Scope and importance of under exploited vegetable crops

2. Asparagus
3. Leek
4. Chinese chive
5. Red cabbage
6. Chinese Cabbage
7. Kale
8. Sweet corn
9. Baby corn
10. Celery
11. Parsley
12. Indian Spinach
13. Spinach
14. Chenopods
15. Cherkumanis and indigenous vegetables regional importance
16. Mid semester examination
17. Sweet gourd
18. Spine Gourd
19. Teasle Gourd
20. Round gourd
21. Little (or) Ivy gourd
22. Snake gourd
23. Pointed gourd
24. Kachri
25. Long melon
26. Snap melon
27. Gherkin
28. Elephant foot yam
29. Yam
30. Yam bean
31. Lime bean
32. bean

### **Practicals**

- Identification and botanical description of plants and varieties;
- Seed/ planting material;
- Production, lay out and method of planting;
- Important cultural operations;
- Identification of important pests and diseases and their control;
- Maturity standards and harvesting;
- Visit to local farms.

### **Practical**

1. Identification of under exploited vegetables
2. Seed treatment and nursery practices.
3. Propagation techniques for exotic vegetable crops
4. Layout and planting of under exploited and exotic vegetables
5. Nutrient and fertigation practices in under exploited and exotic vegetables
6. Intercultural operations in under exploited and exotic vegetables

7. Study of nutritional and physiological disorders.
8. Maturity standards and harvest indices in under exploited and exotic vegetables.
9. Seed production techniques in under exploited vegetables
10. Seed production techniques in exotic vegetables.
11. Identification and management of pests in under exploited and exotic vegetables.
12. Identification and management of diseases in under exploited and exotic vegetables.
13. Post-harvest and processing techniques for under exploited and exotic vegetables
14. Visit to commercial unit of protected cultivation / field.
15. Visit to commercial post-harvest handling unit / vegetable markets
16. Working out cost economics.
17. Final Practical Examination

### Course outcome

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

- CO 1: Appreciate the scope and scenario of production of underutilized vegetable in India
- CO 2: Acquire knowledge about the production technology of underutilized vegetable crops
- CO 3: Adopting production of lesser utilised crops as entrepreneur
- CO 4: Acquire knowledge on maturity indices and Post-harvest management of under exploited vegetables.
- CO 5: Acquire knowledge about seed production technology of underutilized vegetable crops.

### CO-PO MAPPING MATIRX:

	PO 1	PO 2	PO 3	PO 4	PO 5
CO-1	1	1	1	-	-
CO-2	3	1	2	2	-
CO-3	3	2	3	3	1
CO-4	3	1	2	2	-
CO-5	3	2	1	2	1

### Suggested Reading

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2. Indira P and Peter KV. 1984. Unexploited tropical vegetables. Kerala agricultural university, Kerala.
3. Pandey AK. 2011. Aquatic vegetables. Agrotech publisher academy, New Delhi.
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6. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume II and III. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509 p.
7. Rana MK. 2018. Vegetable crop science. CRC Press Taylor and Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742 ISBN: 978-1-1380-3521-8
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10. S K Sanwal, Underutilized Vegetable and Spice crops (2008).

**Suggested websites :**

<http://www.researchgate.net>

<http://www.ijcmas.com>

<http://www.slideshare.net>

<http://www.phytojournal.com>

<http://www.gbphedervis.nic.in>

## **VSC 510 -SYSTEMATICS OF VEGETABLE CROPS (1+1)**

### **Learning Objectives**

- To gain knowledge on systematics and crop diversity in vegetable crops
- To understand the origin, evolution and distribution of vegetable crops.
- To learn botanical and morphological description of tropical, subtropical and temperate vegetable crops.
- To learn the cytological level of various vegetable crops.
- To gain knowledge on the importance of molecular markers in characterization and taxonomy of vegetable crops.

### **Theory**

#### **Unit I**

Significance of systematic – Significance of systematics and crop diversity in vegetable crops; Principles of classification; different methods of classification; Salient features of international code of nomenclature of vegetable crops

#### **Unit II**

Origin and evolution – Origin, history, evolution and distribution of vegetable crops

#### **Unit III**

Botanical and morphological description – Botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables; Morphological keys to identify important families, floral biology, floral formula and diagram; Morphological description of all parts of vegetables

#### **Unit IV**

Cytology – Cytological level of various vegetable crops with descriptive keys

#### **Unit V**

Molecular markers – Importance of molecular markers in evolution of vegetable crops; Molecular markers as an aid in characterization and taxonomy of vegetable crops

### **Practicals**

- Identification, description, classification and maintenance of vegetable species and varieties;
- Survey, collection of allied species and genera locally available;
- Preparation of keys to the species and varieties;
- Methods of preparation of herbarium and specimens.

### **Lesson plan**



1. Significance of systematics and crop diversity in vegetable crops
2. Principles of classification
3. Different methods of classification
4. Salient features of international code of nomenclature of vegetable crops
5. Origin, history, evolution and distribution of vegetable crops
6. Botanical description of genera and species of Solanaceae and Malvaceae family
7. Botanical description of genera and species of Cucurbitaceae and Alliaceae family
8. Botanical description of genera and species of Cruciferae family
9. Mid-semester examination
10. Botanical description of genera and species of Fabaceae, Moringaceae and Amaranthaceae family
11. Botanical description of genera and species of Asteraceae, Euphorbiaceae and Convolvulaceae family
12. Botanical description of genera and species of Araceae, Dioscoreaceae and Labiatae family
13. Morphological keys to identify important families, floral biology, floral formula and diagram
14. Morphological description of all parts of vegetables
15. Cytological level of various vegetable crops with descriptive keys
16. Importance of molecular markers in evolution of vegetable crops
17. Molecular markers as an aid in characterization and taxonomy of vegetable crops

### **Practical**

1. Identification, description, classification and maintenance of vegetable species and
  - a. varieties of Solanaceae family
2. Identification, description, classification and maintenance of vegetable species and
  - a. Varieties of Cucurbitaceae family-gourds
3. Identification, description, classification and maintenance of vegetable species and
  - a. Varieties of Cucurbitaceae family-melons
4. Identification, description, classification and maintenance of vegetable species and
  - a. Varieties of Alliaceae family
5. Identification, description, classification and maintenance of vegetable species and
  - a. Varieties of Cruciferae family
6. Identification, description, classification and maintenance of vegetable species and
  - a. varieties of Umbelliferae family
7. Identification, description, classification and maintenance of vegetable species and
  - a. varieties of Chenopodiaceae family
8. Identification, description, classification and maintenance of vegetable species and
  - a. varieties of Fabaceae family
9. Identification, description, classification and maintenance of vegetable species and
  - a. varieties of Moringaceae family
10. Identification, description, classification and maintenance of vegetable species and
  - a. varieties of Amaranthaceae family
11. Identification, description, classification and maintenance of vegetable species and
  - a. varieties of Malvaceae family
12. Identification, description, classification and maintenance of vegetable species and

- a. varieties of Asteraceae family
- 13. Identification, description, classification and maintenance of vegetable species and
  - a. varieties of Euphorbiaceae and Convolvulaceae family
- 14. Identification, description, classification and maintenance of vegetable species and
  - a. varieties of Araceae, Dioscoreaceae and Labiatae family
- 15. Collection of locally available allied species, genera and preparation of keys for the species and varieties
- 16. Methods of preparation of herbarium
- 17. Methods of preparation of specimens

**Course outcome**

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

**CO 1:** Acquire knowledge on identification, description, classification and maintenance of vegetable species and varieties

**CO 2:** Appreciate the role of molecular markers in characterization and taxonomy of vegetable crops.

**CO 3:** Collecting locally available allied species of vegetable crops,

**CO 4:** Acquire knowledge about cytological level of various vegetable descriptive keys

**CO 5:** acquire knowledge about preparing herbarium and specimens

**CO-PO MAPPING MATIRX**

	PO 1	PO 2	PO 3	PO 4	PO 5
CO-1	2	-	-	-	-
CO-2	2	2	-	-	-
CO-3	3	2	1	1	-
CO-4	2	2	2	1	1
CO-5	1	1	-	-	-

**Suggested reading**

1. Chopra GL. 1968. *Angiosperms- systematics and life cycle*. S. Nagin
2. Dutta AC. 1986. *A class book of botany*. Oxford Univ. Press.
3. Pandey BP. 1999. *Taxonomy of angiosperm*. S. Chand and Co
4. Peter KV and Pradeepkumar T. 2008. *Genetics and breeding of vegetables*. (Revised), ICAR.
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6. Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.
7. Hayward MD, Bosemark NO & Romagosa I. (Eds.). 1993. *Plant Breeding Principles and Prospects*. Chapman & Hall.
8. Kalloo G. 1988. *Vegetable Breeding*. Vols. I-III. CRC Press.
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13. Rai N & Rai M. 2006. Heterosis Breeding in Vegetable Crops. New India Publ. Agency.
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16. Singh BD. 1983. Plant Breeding. Kalyani.
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18. Swarup V. 1976. Breeding Procedure for Cross-pollinated Vegetable Crops. ICAR.

**Website:**

35. <http://www.aushs.org.au/>
36. <http://www.icar.org.in>
37. [www.kau.edu](http://www.kau.edu)
38. [www.iihr.res.in](http://www.iihr.res.in)
39. <http://www.hillagri.ac.in>

## **VSC 511 ORGANIC VEGETABLE PRODUCTION (1+1)**

### **Learning Objectives**

- To educate principles, concepts and production of organic farming in vegetable crops.
- To impart knowledge on special techniques followed in organic vegetable cultivation.
- To gain knowledge about managing soil fertility, under organic system of cultivation.
- To impart skill on different indigenous methods of composting.
- To educate about organic certification and export opportunity in vegetables.

### **Theory**

#### **Unit I Importance and principles of organic farming**

Importance and principles – Importance, principles, perspective, concepts and components of organic farming in vegetable crops

#### **Unit II Organic production of vegetables**

Organic production of vegetables – Organic production of vegetable crops, viz., Solanaceous, Cucurbitaceous, Cole, root and tuber crops

#### **Unit III. Managing soil fertility**

Managing soil fertility – Managing soil fertility, mulching, raising green manure crops, weed management in organic farming system; Crop rotation in organic production; Processing and quality control of organic vegetable produce

#### **Unit IV. Composting methods**

Composting methods – Indigenous methods of composting, Panchyagavya, Biodynamics preparations and their application; ITKs in organic vegetable farming; Role of botanicals and bio-control agents in the management of pests and diseases in vegetable crops

#### **Unit V Certification and export**

Certification and export – Techniques of natural vegetable farming, GAP and GMP certification of organic products; Export- opportunity and challenges

### **Lesson plan**

1. Importance, Principles, Perspectives Concepts, of organic vegetable production.
2. Components of organic farming in vegetable crops.

3. Organic production of solanaceous vegetables.
4. Organic production of cucurbitaceous vegetables.
5. Organic production of cole crops
6. Organic production of root and tuber crops vegetables.
7. Mulching and raising green manure crops in organic farming system
8. Weed management in organic family system.
9. Crop rotation in organic farming system production.
10. Processing and quality control of organic vegetable produce.
11. Indigenous methods of composting
12. Panchagavya preparation and their applications.
13. ITKS in organic vegetable farming.
14. Role of botanical and bio-control agents in organic farming.
15. Techniques of natural vegetable farming
16. GAP and GMP certification of organic products.
17. Export opportunity and challenges organic vegetable production.

### **Practical**

Soil physical parameters with relevance to organic horticulture- method of preparation of compost- vermicomposting- biofertilizers- soil solarization- bio pesticides in horticulture- green manuring- mycorrhizae and organic crop production- waste management- organic soil amendment for root disease- weed management in organic horticulture- visit to organic fields and marketing centres

1. Soil physical parameters with relevance to organic horticulture.
2. Estimate on soil chemical parameters (pH, EC and ESP).
3. Estimation of Soil biological parameters.
4. Nursery bed soil solarization for vegetable crops.
5. Agro techniques for composting farm wastes and agro industrial wastes.
6. Recycling of crop wastes through vermiculture.
7. Preparation of panchakavya humic acid and sea weed extract.
8. Preparation of activated EM solution, Manchurian mushroom tea and vermiwash.
9. Organic production of vegetable crops.
10. Application of various mulch materials to horticultural crops.
11. Study of bio agents for crop protection.
12. Preparation of organic formulations for pest control.
13. Preparation of organic formulations for disease control.
14. Organic certification, standards and agencies.
15. Working out indices for organic horticulture.
16. Economic evaluation of organic horticulture system.
17. Visit to farmer's field under organic cultivation.

### **Course outcome:**

**CO 1:** Appreciate the scope and scenario of organic vegetable production in India

**CO 2:** To acquire knowledge about organic vegetable production technology.

**CO 3:** They will be able to establish various organic input production units

**CO 4:** To gain knowledge about organic certification, marketing and export of organic vegetables.

**CO 5:** Adopting production of organic vegetable crops as entrepreneur.

#### CO - PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO-1	2	2	1	1	-
CO-2	3	1	1	1	1
CO-3	1	2	2	2	1
CO-4	1	1	1	2	2
CO-5	3	2	2	2	1

#### References

1. Allen V.Baker. 2010. Science and Technology of Organic farming. CRC press, Boca Raton.
2. Dahama, A.K. 2005. Organic Farming for Sustainable Agriculture. 2nd Ed Agrobios, Jodhpur
3. Gareth Danies and Margi Tennartssan.2012. Organic Vegetable Production: A complete guide. The Crossword Press, United Kingdom
4. Gehlot, G. 2005. Organic Farming; Standards, Accreditation Certification and Inspection. Agrobios, Jodhpur.
5. Joann, K. Whalen and Luis.2009. Sampedru. Soil Ecology and Management. CABI, United Kingdom
6. Lampkin, N.1990.Organic farming Farming Press, USA.
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8. Pradeepkumar, T., B. Suma, Jyothibhaskar and K.N. Satheesan. 2008. Management of Horticultural Crops. New India Publ., New Delhi.
9. ReetaGhosla. 2017. Biofertilizers and Biocontrol agents for organic farming. Kojo Press, New Delhi
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11. Somasundaram, E., D. UdhayaNandhini and M. Meyappan. Principles of organic farming. New India Publishing Agency, New Delhi.
12. UshaNandini Devi, Hari Narayanan and Pugalendhi Lakshmanan.2021. Organic vegetable cultivation. Intech-open publications, New Delhi.

#### Suggested websites

1. [www.intechopen.com](http://www.intechopen.com)
2. <https://www.iivr.icar.gov.in>
3. <https://www.krishisewa.com>
4. <https://www.agrifarming.in>

5. [http://agritech.tnau.ac.in/seed\\_certification/seedtech\\_index.html](http://agritech.tnau.ac.in/seed_certification/seedtech_index.html)

## VSC 512 PRODUCTION TECHNOLOGY OF SPICE CROPS (2+1)

### Learning Objectives

1. To gain comprehensive knowledge about diversification of spices, scope, importance, export and employment potential of spice crops grown in India
2. To acquire skills on production and processing of spices.
3. To gain knowledge in Good Agricultural practices in spice production.
4. To acquire knowledge about organic production and certification of spices.
5. To gain knowledge on protected cultivation of spice crops.

### Theory

Introduction- importance of spice crops-historical accent- present status - national and international- future prospects- botany and taxonomy- climatic and soil requirements- commercial varieties/hybrids- site selection- layout- sowing/planting time and methods- seed rate and seed treatment- nutritional and irrigation requirements- intercropping- mixed cropping- intercultural operations- weed control- mulching- physiological disorders- harvesting- Post-harvest 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:

### Unit I Production technology of major spices- I

Black pepper, small cardamom, large cardamom.

### Unit II Production technology of major spices -II

Turmeric, ginger and garlic

### Unit III Production technology of tree spices

Clove, cinnamon, nutmeg and allspice

### Unit IV Production technology of seed spices

Coriander, fenugreek, cumin, fennel, ajowan, dill and celery

### Unit V Production technology of minor spice crops

Tamarind, garcinia and vanilla

### Current Stream of Thought Practicals

Identification of seeds and plants- botanical description of plants preparation of herbarium- propagation- nursery raising- field layout and method of planting- cultural practices- harvesting- drying- storage- packaging and processing- value addition; short term experiments on spice crops.

## Lesson plan

1. History and classification of spices
2. Scope and importance, area, production, productivity, export potential of spices.  
Crop improvement, varieties, propagation and production technology of the following crops:
- 3-4. Black Pepper
- 5-6. Cardamom
- 7-8. Turmeric
9. Ginger
- 10-11. Garlic
12. Clove
- 13-14. Cinnamon
15. Nutmeg
16. Allspice
17. mid semester examination
18. Coriander
19. Fenugreek
20. Cumin
21. Fennel
22. Ajowain
23. Dill
24. Celery
- 25-26. Tamarind
27. Garcinia
28. Vanilla
29. Organic spice production
- 30-31 Precision farming practices in spice.
- 32-33. Role of commodity boards in spice development.
33. Good Agricultural Practices for spice production

## Practical

1. Description of related species and varieties of black pepper and cardamom
2. Propagation and rapid multiplication in pepper and cardamom
3. Processing of pepper and cardamom
4. Description of related species and varieties of turmeric and ginger
5. Processing of turmeric and ginger
6. Description of related species and varieties of garlic
7. Description of related species and varieties of tree spices
8. Nursery techniques in tree spices
9. Description of related species and varieties of seed spices
10. Nursery techniques in seed spices
11. Description of related species and varieties of tamarind, garcinia, vanilla
12. Preparation of spice herbarium
13. Protected cultivation of spices
14. Value addition in spices
15. Project preparation
16. Visit to spice gardens
17. Visit to commodity boards

### Course outcome

**CO 1:** Students will be able to appreciate the research advancements made in spice crops.

**CO 2:** They will be able to recommend suitable package of practices for enhanced spice production.

**CO 3:** They will acquire knowledge about processing of spice crops

**CO 4:** The students will be able to get skill on different value-added products of spice crops.

**CO 5:** To study about organic cultivation of spice crops

### CO - PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO-1	1	2	1	1	-
CO-2	3	2	2	2	1
CO-3	3	1	1	1	1
CO-4	2	1	1	1	-
CO-5	3	2	2	2	1



## References

1. Agarwal, S., E.V.D. Sastry. And R.K. Sharma. 2001. Seed Spices: Production, Quality, Export. Pointer Publ,Jaipur
2. Arya,P.S.2000.Spice Crops of India. KalyaniPublishers,NewDelhi.
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11. Tiwari, R.S. and A. Agarwal. 2004. Production Technology of Spices. International Book Distr. Co, NewDelhi.

## Suggested website:

- 1 <https://annamalaiuniversity.ac.in>
- 2 <https://icar.org.in>
- 3 <https://agritech.tnau.ac.in>
- 4 <http://www.hillagric.ac.in>
- 5 <https://ivtc.avrdc.org/>

## VSC 513 PROCESSING OF VEGETABLE CROPS (1+1)

### Learning Objectives

1. To educate principles and practices of processing of vegetable crops.
2. To understand the role of microorganisms in food processing industry
3. To acquire skill about the different produces for establishing a processing industry
4. To have a knowledge about utilization of byproducts and waste management of processing industry.
5. To learn about the recent advances made in processing and value addition of vegetable crops.

## **Theory**

### **Unit I Present status of vegetable preservation industry in india.**

History of food preservation- scope and importance of processing of vegetables- present status and future prospects of vegetable preservation industry in India- concept and principle of vegetable processing- nutritive value and nutraceutical properties of vegetables.

### **Unit II Role of microorganisms in food preservation**

Role of microorganisms in food preservation- spoilage of fresh and processed horticultural produce; biochemical changes and enzymes associated with spoilage of horticultural produce; principal spoilage organisms- food poisoning and their control measures.

### **Unit III Processing equipments**

Raw materials for processing- primary and minimal processing; processing equipments- nutritionally enriched / fortified products- layout and establishment of processing industry- importance of hygiene and plant sanitation.

### **Unit IV Quality control**

Quality assurance and quality control- TQM- GMP- food standards FSSAI - BIS- AGMARK- Codex Alimentarius- fruit products order (FPO)- FPO licence-- PFA- etc.- food laws and regulation- food safety- hazard analysis and critical control points (HACCP)- role of NHB- APEDA- Labelling and labelling act and nutrition labelling.**Unit V Value addition and management of wastes from processing industries**

Management of waste from processing industry- major value added products from vegetables. Utilization of by- products of vegetable processing industry- investment analysis- principles and methods of sensory evaluation of fresh and processed vegetables.

### **Practicals**

Experiments on extension of shelf life- experiments on methods of preservation- changes occurring during preservation- various methods of preservation of products- study of machinery and equipments used in processing of horticultural produce- chemical analysis for nutritive value of fresh and processed vegetables- study of different types of spoilages in fresh as well as processed horticultural produce- classification and identification of spoilage organisms- study of biochemical changes and enzymes associated with spoilage- laboratory examination of vegetable products- sensory evaluation of fresh and processed vegetables- study of food standards - national- international- codex alimentarius- visit to processing units to study the layout- equipments- hygiene- sanitation and residual / waste management.

### **Lesson plan**

1. History of food preservation –scope and importance of vegetable processing
2. Concept and principle of vegetable processing-nutritive value and nutraceutical properties of vegetable produce.
3. Present status and future prospects of vegetable preservation industry in India.
4. Role of microorganisms in food preservation- spoilage of fresh and processed horticultural produce.
5. Biochemical changes and enzymes associated with spoilage of horticultural produce- principal spoilage organisms,
6. Food poisoning and their control measures.

7. Mid-semester examination
8. Raw materials for processing.
9. Primary and minimal processing of vegetable crops.
10. Processing equipments; nutritionally enriched / fortified products.
11. Layout and establishment of processing industry, FPO licence. Importance of hygiene-plant sanitation.
12. Quality assurance and quality control, TQM, GMP.
13. BIS, AGMARK, Codex Alimentarius – food standards FPO, PFA, etc.
14. Food laws and regulation- food safety- hazard analysis and critical control points (HACCP).
15. Labeling and labeling act, nutrition labeling.
16. Major value added products from vegetables. Utilization of byproducts of vegetable processing industry-
17. Management of waste from processing factory- Investment analysis. Principles and methods of sensory evaluation of fresh and processed vegetables.

**Practical schedule**

1. Experiments on methods of preservation, changes occurring during preservation.
2. Study of machinery and equipments used in processing of horticultural produce.
3. Preparation of sauce and ketchup.
4. Processing of osmo dried vegetable products.
5. Preparation of pickles and sauces.
6. Processing of dehydrated vegetables.
7. Estimation of protein
- 8 Study of food standards. National, international standards.
9. Visit to processing units, to study the layout, equipments, hygiene, sanitation and residual / waste management.

**Course Outcome**

- CO 1:** The students will learn about the processing of different vegetable crops.  
**CO 2:** Acquire skill on value added products of vegetable crops.  
**CO 3:** Acquire knowledge about different type of equipments used in processing sectors.  
**CO 4:** Through knowledge about management of waste from processing industry.  
**CO 5:** They will be able to prepare a proposal for establishing a vegetable processing unit

**CO - PO Mapping matrix**

	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>
<b>CO-1</b>	<b>2</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>-</b>
<b>CO-2</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>-</b>
<b>CO-3</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>
<b>CO-4</b>	<b>2</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>1</b>
<b>CO-5</b>	<b>3</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>-</b>

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3. Fellow'sp. 1988. Food processing technology. Ellis Horwood international.
4. Giridharilal, G.S., Siddappa. and G.L. Tandon. 1986. Preservation of Fruits and vegetables. Publication and Information Division, New Delhi.
5. Pandit P.S. 2014. Post-harvest technology and processing of horticulture crops at a glance. New India Publishing Agency, New Delhi.
6. Srivastava RP and Kumar S. 2003. Fruit and vegetable preservation. Principles and practices. 3<sup>rd</sup> Ed. International Book Distri.co.
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11. Joslyn M & Heid. Food Processing Operations. AVI Publ. Co.
12. Mahindru SN. 2004. Food Safety: Concepts and Reality. APH Publ. Corp.
13. Ranganna S. 1986. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Ed. Tata-McGraw Hill.
14. Shapiro R. 1995. Nutrition Labeling Handbook. Marcel Dekker.

## Suggested website:

1. <http://www.ctcri.org/>
2. <http://www.iari.res.in/>
3. <http://www.fao.org>
4. [www.kau.edu](http://www.kau.edu)
5. <http://jnkvv.org>

## VSC 514 POSTHARVEST MANAGEMENT OF VEGETABLE CROPS (2+1)

### Learning Objectives

1. To learn about the Post-harvest scenario and causes for Post-harvest losses of vegetable crops
2. To understand the physiology and biochemistry of fruit ripening.
3. To learn about the maturity indices, standards and methods of maturity determination in different vegetable crops.
4. To have a skill on commodity pretreatments, packaging and transport of vegetable crops.
5. To study about the different methods of storage of vegetable crops.

### Theory

#### Unit I Post-harvest technology scenario of vegetable crops

Importance and scope of Post-harvest technology- Post-harvest technology scenario of

vegetable crops in India-causes of Post-harvest losses. Factors leading to post harvest technology.

### **Unit II Maturity indices and biochemistry.**

Maturity indices and standards for different vegetables-maturity indices and standards for different vegetables-methods of maturity determination-biochemistry of maturity and ripening-Enzymatic and textural changes-Ethylene evolution and ethylene management-Respiration and transpiration along with their regulation methods.

### **Unit III Harvesting and post-harvest losses.**

Harvesting tools and practices for specific market requirement-Post-harvest physical and biochemical changes-pre harvest practices and other factors affecting post-harvest losses.

### **Unit IV Packing house operations**

Packing house operations-commodity pretreatments-chemicals, wax coating, pre-cooling and irradiation-packaging of vegetables, prevention from infestation-management of post-harvest diseases and principles of transportation.

### **Unit V Methods of storage**

Storage methods-ventilated, refrigerated, modified atmosphere and controlled atmosphere storage, hypobaric storage and cold storage; Zero energy cool chamber, storage disorders-chilling injury in vegetables.

### **Practical**

Studies on stages and maturity indices ripening of commercially important vegetable crops-studies of harvesting, pre-cooling, pretreatments, physiological disorders-chilling injury-improved packaging-use of chemicals for ripening and enhancing shelf-life of vegetables-physiological loss in weight-estimation of transpiration, respiration rate and ethylene release, storage of important vegetables-cold chain management-visit to commercial packing house, cold storage and controlled atmosphere storage.

### **Lesson plan**

18. Post-harvest technology scenario in vegetable crops
19. Importance and scope of post-harvest technology.
20. Causes of Post-harvest losses and methods to overcome post-harvest losses.
21. Harvest indices and harvesting methods.
22. Physical and horticultural maturity.
23. Biochemistry of maturity and ripening-
24. Enzymatic and textural changes during ripening
25. Ethylene evolution and ethylene management
26. Role of ethylene in post-harvest technology.
27. Harvesting practices for specific market requirements.
28. Influence of pre harvest factors on post-harvest quality and shelf life of horticultural crops,
29. Factors leading to post-harvest technology.
30. Packing house operations-commodity pretreatments.
31. Pre-cooling, treatments prior to transport
32. Grading of vegetables, vapour heat treatment and fumigation
33. Waxing technology of vegetables.
34. Irradiation technology.

35. Packaging materials for vegetables.
36. Methods of packing
37. Controlled and modified atmospheric packing
38. Vacuum, edible packaging
39. Packaging technology for export by road, air and sea for vegetables.
40. Storage methods *viz.*, ventilated and refrigerated.
41. Mid-semester examination
42. Management of Post-harvest diseases.
43. Principles of transportation.
44. Methods of storage for local and distant market.
45. Ventilated and refrigerated storage.
46. Modified Atmospheric storage (MAS).
47. Controlled atmospheric Storage (CAS).
48. Hypobaric storage and cold storage
49. Storage consideration temperature, humidity, atmospheric composition etc.
50. Low cost storage structures-zero energy cool chambers.
51. Physical injuries and disorders during storage.

#### **Practical schedule**

7. Exercise on harvesting of fruit based on maturity indices.
8. Ripening of commercially important vegetable crops.
9. Pre-cooling, grading, washing and waxing treatments.
10. Collection and practicing usage of various packaging materials.
11. Experiments to hasten ripening-of fruits.
12. Experiments on extension of shelf-life vegetable crops.
13. Practice in judging the maturity of vegetable crops
14. Use of plant growth regulators in post-harvest technology.
15. Experiments on use of chemicals for ripening
16. Experiments on use of chemicals for enhancing shelf life of vegetables.
17. Estimation of physiological loss in weight, estimation of respiration, transpiration rate and ethylene release.
18. Exercise on storage studies of vegetables.
19. Experiments on low-cost storage structures.
20. Chemical analysis for nutritive value of fresh vegetables.
21. Cold chain management of vegetables
22. Visit to cold storage and control atmospheric storage
23. Visit to commercial packing house

#### **Course Outcome**

**CO1:** The students will be acquire knowledge on different techniques to prevent the Post-harvest losses of vegetable crops.

**CO2:** The students acquire skill about handling of freshly harvested commodities.

**CO3:** The students learn about the role of various chemicals and growth regulators on Post-harvest shelf-life of vegetable crops.

**CO4:** They will be acquire skill about the various methods of storage of horticultural produce.

**CO5:** They will be able to prepare a proposal for establishing a commercial packing house.

**CO - PO Mapping matrix**

	PO 1	PO 2	PO 3	PO 4	PO 5
CO-1	2	2	1	1	1
CO-2	2	1	1	1	-
CO-3	2	1	1	2	1
CO-4	3	-	1	1	-
CO-5	3	-	2	2	1

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**References**

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2. Chadha, D.S. 2006. The Prevention of Food Adulteration Act. Confed. of Indian Industry, India.
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**Suggested website:**

1. <http://www.ctcri.org/>
2. <http://www.iari.res.in/>
3. <http://www.igzev.de/>
4. [www.kau.edu](http://www.kau.edu)
5. <http://www.aushs.org.au/>