

ANNAMALAI



UNIVERSITY

ANNAMALAINAGAR

Ph.D. (Horticulture)

DEGREE PROGRAMMES

REVISED SYLLABUS

2019-2020

**COMMON REGULATIONS TO ALL PH.D. DEGREE PROGRAMMES OF
FACULTY OF AGRICULTURE
(FULL-TIME / PART-TIME / EXTERNAL)
(2019-2020)
REGULATIONS**

1. SYSTEM OF EDUCATION

- 1.1 These rules and regulations shall govern the Ph.D. Programmes leading to the award of Degree of Doctor of Philosophy in the concerned subject in the Faculty of Agriculture, Annamalai University. They shall come into force with effect from the academic year 2019-2020.
- 1.2 The semester system shall be followed for all the Ph.D. degree programmes.
- 1.3 The duration of doctoral programmes is as follows:

| Programme | Minimum Years | Maximum Years |
|-----------------------------|----------------------|----------------------|
| Full Time | 3 | 5 |
| Part Time / External | 4 | 6 |

2. DEFINITIONS

- 2.1 An “Academic year” shall consists of two semesters.
- 2.2 “Semester” means an academic term consisting of 105 instructional days excluding final theory examinations.
- 2.3 “Course” means a unit of instruction to be covered in a semester having specific No., title and credits.
- 2.4 “Credit hour” means, one hour lecture plus two hours of library or home work or two and half hours of library/field practicals per week in a semester.
- 2.5 ‘Credit load’ of a student during a semester is the total number of credits registered by that student during that particular semester.
- 2.6 ‘Grade Point’ of a course means the value obtained by dividing the percentage of marks earned in a course by 10 and the Grade Point is expressed on a 10 point scale and rounded off to two decimal places.
- 2.7 ‘Credit Point’ means the grade point multiplied by corresponding credit hours.
- 2.8 ‘Grade Point Average’(GPA) means the quotient of the total credit points obtained by a student in various courses 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 scale and the GPA has to be corrected to two decimals.
- 2.9 ‘Overall Grade Point Average’ (OGPA) means the quotient of cumulative credit points obtained by a student in all the courses 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. PROGRAMMES OFFERED

The details of various Ph.D. programmes offered in the Faculty of Agriculture are as follows:

- Agrl. Business Management**
- Agrl. Economics**
- Agrl. Entomology**
- Agrl. Extension**
- Agrl. Microbiology**
- Agrl. Biotechnology**
- Agronomy**

Genetics and Plant Breeding
 Horticulture
 Plant Pathology
 Seed Science & Technology
 Soil Science and Agrl. Chemistry

4. ELIGIBILITY FOR ADMISSION

Candidates seeking admission to Ph.D. programme should satisfy the following requirements.

4.1 Candidates with two year master's degree programmes from Universities recognized by Annamalai University are eligible to apply for Ph.D. programmes of the university (Table 1).

4.2 Candidates who have undergone the programme under conventional system should possess not less than a second class Master's degree. The candidates under trimester system should possess a minimum OGPA of 3.00 out of 4.00. For those under semester system 7.00 out of 10.00 is required for various Doctoral programmes. However, this will not apply to SC/ ST candidates, nominees of State Government / Annamalai University / ICAR / and Government of India for whom a pass in the concerned degree is sufficient.

Table - 1: Eligibility Criteria

| Doctoral Degree Programmes | Eligibility |
|--------------------------------------|--|
| 1. Agrl. Business Management | MBA in Agribusiness |
| 2. Agrl. Economics | M.Sc.(Ag.) in Agrl. Economics/ Agrl. Marketing Management. |
| 3. Agrl. Entomology | M.Sc.(Ag.) in Entomology |
| 4. Agrl. Extension | M.Sc.(Ag.) in Agrl. Extension |
| 5. Agrl. Microbiology | M.Sc.(Ag.) in Agrl. Microbiology |
| 6. Agrl. Biotechnology | M.Sc.(Ag.) in Genetics and Plant Breeding / Agrl. Biotechnology |
| 7. Agronomy | M.Sc.(Ag.) in Agronomy |
| 8. Genetics and Plant Breeding | M.Sc.(Ag.) in Genetics and Plant Breeding |
| 9. Horticulture | M.Sc (Ag.) Hort. / M.Sc. (Hort.) /M.Sc. (Hort.) in Fruit Science / Vegetable Science/Floriculture and Landscape Gardening or Architecture / Plantation, Spices, Medicinal and Aromatic Crops |
| 10. Plant Pathology | M.Sc.(Ag.) in Plant Pathology |
| 11. Seed Science & Technology | M.Sc.(Ag.) in Seed Science & Technology |
| 12. Soil Science and Agrl. Chemistry | M.Sc.(Ag.) in Soil Science and Agrl. Chemistry |

4.3 Full time programme:

All full time research scholars shall undergo course work for two semesters as prescribed by the Department. Duration of the programme will be for three years.

4.4 Part Time Programme

The part time programme will be offered to the in-service candidates / Research Scholars of projects of Annamalai University. The candidates of this University should route their application through HOD and Dean, Faculty of Agriculture. The duration of the programme will be of 4 years. The in-service candidates / Research Scholars of projects of Annamalai University will be permitted to register the Ph.D. programme by course work and they have to undergo one year course work by utilizing any eligible leave for that period.

4.5. External Registration

The duration of the programme will be of 4 years. The following are the additional conditions for registration for a Ph.D. programme under external category

1. The candidates must register under a research supervisor who is a member of the Teaching Faculty of this University
2. The candidate should be working as Asst. Professor/Associate Professor/Professor or in equivalent positions on permanent basis in a recognized college where facilities for carrying out research work are available and have post graduate departments for Agrl. subjects or working as research assistants in private or government institutions having research and development facilities and who fulfill the eligibility conditions.
3. The candidate should have a recognized co-supervisor in parent department of the organization. The co-supervisor may be from other colleges / organization located from the same place if such persons are not available in the parental organizations.
4. The candidate shall undergo the course of the required credits during I year of the programme in Annamalai University Campus. He / She shall carryout the research at his / her parental organization for the entire of period of the programme.
5. NOC (No Objection Certificate) is to be produced from the employer of the institution / Organization where he / she is working and attached along with the application ii. Co-supervisor acceptance letter should be also be enclosed with the application form.

5. SELECTION PROCEDURE

A candidate who wishes to undertake Ph.D. programme of this University either full time or part time or external registration should apply in the prescribed form on or before the due date.

Applications which fulfil the above conditions (mentioned in the Prospectus) will be scrutinized by a Departmental Research Committee consisting of the Head of the Department (Coordinator), two Professors, one senior Associate Professor and one senior Assistant Professor (not more than five). Eligible candidates will have to appear for entrance test and interview on the dates specified by the University. The selection of the candidates shall be based on marks obtained in the qualifying degree, a written test and an interview. The weightage for Qualifying Degree Examination will be given for 50 marks. The written test shall comprise objective type questions and examine research aptitude, grasp of the subject, intellectual ability and general knowledge of the prospective candidates. The question paper for the written test shall be prepared for one hour duration. Question papers will be set and evaluated by the DRC for 25 marks. The interview will be conducted for 25 marks. The cut off marks for the selection shall be fixed as 50 percent. NET qualified candidates are exempted from the entrance test, but they have to appear for the interview. The minutes of the DRC together with the recommendation will be placed before the Vice-Chancellor who in consultation with the Dean of the Faculty and Head of the Department will select and admit the applicant to work under the guide proposed.

6. CREDIT GRADE POINT REQUIREMENTS

6.1. A student enrolled for Doctoral program to become eligible for the degree is required to complete 75 credits inclusive of 45 credits of research as detailed below

| Sl.No. | Details | Credit Hours |
|---------------|--------------------|---------------------|
| 1. | Major-Courses | 15 |
| 2. | Minor-Courses | 8 |
| 3. | Supporting-Courses | 5 |
| 4. | Seminar | 2 |
| 5. | Research | 45 |
| | Total | 75 |

6.2. In a semester, a full time Ph.D. student can register a maximum of 15 credits excluding research. However, the research credits registered should not exceed 12 per semester. Semester wise distribution of credits are given in the respective Ph.D., programmes. The total research credits for PT and EXT candidates should be distributed in all the eight semesters. The Ph.D. students (FT/PT/EXT) should complete their course work within two semesters in the first year in Annamalai University campus.

6.3. Requirements for Ph.D. programme shall also include successful completion of thesis research in the major field of study and submission of thesis thereon.

7. ATTENDANCE REQUIREMENT

7.1. "One hundred percent attendance is expected from each scholar. A student who fails to secure 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 shall be awarded 'E' (incomplete) and will be required to repeat the subject when ever offered.

7.2. In respect of the student who has absented himself / herself for classes with or without valid reasons, that period will be treated as absence only and not as leave. Also, no attendance will be given for writing make up tests.

7.3 In case of new admission, for calculating 80 percent attendance in the first semester, the number of working days will be calculated from the date of joining of the students who are permitted to join late due to administrative reasons. However, for genuine reasons, condonation of attendance deficiency may be considered by the Vice - chancellor on the recommendation of the Advisory committee, HOD and Dean, Faculty of Agriculture on payment of condonation fee prescribed by the university.

7.4 Students absenting from the classes with prior permission of the HOD on official University business shall be given due consideration in computing attendance.

7.5. In respect of students who had absented for the mid-semester examination on University business with prior permission of the HOD and Dean, Faculty of Agriculture, the make up mid-semester examination should be conducted ordinarily within 15 working days from the date of conduct of the mid-semester examination.

7.6. The students who absent himself/herself for mid-semester examination in a subject on genuine reasons shall be permitted on the recommendation of the course teacher / Research Supervisor and Head of the Department concerned. Missing examination should be completed within 15 working days from the date of respective examination on payment of missing examination fee prescribed by the university.

7.7 An employee of the University admitted to the programme leading to the Ph.D. Degree as a part-time internal candidate in accordance with these ordinances shall be required to work for a minimum period of 30 days per annum during the period of research. They shall carry out research work without affecting their regular duty.

7.8 External scholars are required to mark attendance maintained by the research supervisor/co-supervisor for a minimum compulsory period of 30 days per annum during their period of research.

7.9 External scholars are required to visit Annamalai University campus at the end of every year on a specified date to appear before the Research Advisory Committee (RAC) for review of the progress of their research work.

7.10 The attendance certificate signed by the research supervisor/co-Supervisor shall be sent to the Director, CARE through the respective Head of the Department and the Dean at the time of submission of the Synopsis.

8. RESEARCH ADVISORY COMMITTEE (RAC)

8.1. Each Ph.D. scholar shall have an RAC to guide the student in carrying out his/her programme. A Research Advisory Committee shall be constituted with the approval of

the University for each candidate (full-time, part-time and external) separately, immediately after his/her admission. The purpose of the RAC is to provide expert opinion on frontline research. The Research Advisory Committee shall consist of the Head of the Department or a Professor nominated by the Vice-Chancellor as the Chairperson, the Research Supervisor as the Convener, and two members who are experts in the field nominated by the Vice-Chancellor (one member from the same Department, and the other member from another related Department of our University/another University in Tamil Nadu/other states. The research supervisor in consultation with the HOD will propose the other three members.

8.1.1. Research Supervisor

Every student shall have a research supervisor (among the recognized guides), who will be appointed by the Vice-Chancellor on the recommendation of the Head of the Department and the Dean, Faculty of Agriculture. Research supervisors approved by the Vice-Chancellor only can be the guide for the students. A teacher having Ph.D with 5 years service and PG teaching is eligible for teaching and guiding Ph.D programme. A teacher should have a minimum of three years of service before retirement for allotment of doctoral candidates. The research supervisors who wish to avail leave/lien/deputation beyond a period of six months shall propose a Co-supervisor in the concerned subject for the candidates registered with them and it may be intimated to the University well in advance. The final approval of the proposal rests with the Vice-Chancellor. For external candidate, a Co-supervisor from his/her parental organization will be the Co-Chairman of the Advisory Committee.

8.1.2. Functions of the RAC

The Research Advisory Committee shall have the following functions:

1. Discuss, advice and recommend on all matters connected with the candidate's research from admission till the submission of the thesis.
2. Approve the topic of research and the synopsis.
3. Assess and approve the progress reports of Ph.D. students in the prescribed format and to report to the University on the fitness or otherwise of the candidate to proceed with his/her research work for the Ph.D.
4. If necessary, recommend and approve change of title of dissertation/Thesis, change of research supervisor and status of Researcher (full time to part time and vice-versa)
5. Conduct and supervise the presentation by the candidate of the final draft of his/her proposed thesis for approval before the submission of synopsis of the thesis to the University and to give a certificate to this effect to be submitted along with the synopsis.

8.1.3. The Research Advisory Committee will meet once in six months:

- to scrutinize the research proposal / progress report submitted by the candidate
- to assess the conduct of experiments/field work, peruse laboratory notebooks, data recording, analysis, and publication
- to review and endorse the annual progress report of the candidate.
- to approve the synopsis of the thesis.

The convener will convene the Research Advisory Committee meetings with intimation to the Director, CARE.

8.2. Changes in RAC

The proposals for changes in the RAC is to be sent to the Director, CARE, through HOD and Dean for approval, if it is keenly felt that such changes are absolutely necessary.

8.3. Change of Research Supervisor

8.3.1 Change of research supervisor shall not be permitted as a routine. In exceptional cases, such change may be permitted, if valid reasons are provided by the

candidates. The Committee headed by the Vice-Chancellor shall look into the request of the petitioner, if there is any conflict between the scholar and the research supervisor. The research supervisor under whom the scholar has originally registered shall give a “No Objection Certificate” and the new proposed Research Supervisor should give a “Certificate of Willingness” to guide the candidate. The final decision will rest with the University. However, the Vice-Chancellor, on the recommendation of the RAC and Dean’s Committee, has the right to assign a new research supervisor to the research scholar.

8.3.2 When the change of Research Supervisor is approved, the candidate shall work for a minimum of one year with the new Research Supervisor if the topic of his/her research is different under the new supervisor, provided he/she fulfils the attendance requirements.

8.4 Change of Topic of Research

8.4.1 Change of the specific area of research may be permitted within one year from the date of admission and request must be submitted with the recommendations of the RAC. In such cases, the minutes of the RAC meeting must include whether the course work undertaken by the candidate is relevant to the new research area and the competence of the research supervisor in this field.

8.4.2 If the RAC is of the view that there is a major change in the specific area of research and is not relevant to the course work undertaken, the candidates will have to go through the process of fresh examination pertaining to the area of research.

8.5. Absence of member during qualifying / final Viva-Voce examination

Under extra-ordinary circumstances if the qualifying/ final viva-voce examination to Ph.D. student has to be conducted in the absence of one or two RAC members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Director, CARE in advance.

9. EVALUATION OF STUDENT’S PERFORMANCE

All students shall abide by the rules for evaluating the course work under the semester system of education, as prescribed from time to time by the university.

9.1. Examinations

There will be two examinations viz. mid semester and final examination. Wherever the course has practical, there will be a final practical examination also.

9.2. Grading

- The duration of mid semester examination will be of one hour and final examinations in theory and practical will be conducted for three hours each.
- The mid semester examinations will be conducted by course teachers during the ninth week of the semester as per the scheme drawn by HOD, evaluate and send the marks obtained by the students to the Director, CARE through HOD within seven working days.
- There will be final examination separately for theory and practical which will be conducted by the University. Each final theory and practical examinations will be evaluated by two examiners (one will be the course teacher and another will be the senior faculty of the Department).
- The distribution of marks will be as indicated below:

| S.No | Examination | Course with practical | Course without practical | Course without theory |
|------|-----------------|-----------------------|--------------------------|-----------------------|
| 1 | Mid-semester | 30 | 30 | 30 |
| 2 | Final theory | 40 | 70 | - |
| 3 | Final practical | 30 | - | 70 |
| | Total | 100 | 100 | 100 |

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

Mid semester :

| | | | | |
|----|----------------------|--------------|------------|----------|
| 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 | 5 out of 7 | (5 x 2) | 10 marks |
| 4 | Essay type | 2 out of 3 | (2x5) | 10 marks |

Final Theory:

Courses without practicals (70 marks)

| | | | | |
|----|-------------|------------|----------|----------|
| 1. | Short notes | 5 out of 7 | (5 x 4) | 20 marks |
| 2 | Essay type | 5 out of 7 | (5 x 10) | 50 marks |

Courses with practicals (40 marks)

| | | | | |
|----|-------------|------------|---------|----------|
| 1. | Short notes | 5 out of 7 | (5 x2) | 10 marks |
| 2 | Essay type | 5 out of 7 | (5 x 6) | 30 marks |

9.3. Minimum Marks for Pass

- The student should secure a minimum of 60 per cent marks separately in the theory and practical and an aggregate of 70 per cent to secure a pass in the subject .
- Each subject shall carry a maximum of 100 marks for purpose of grading. The grading will be done as grade point. i.e., the percentage of marks earned in a subject is divided by 10. The grade point is expressed on a 10 point scale upto two decimals.
- Students who secure marks below 70 per cent in a subject will be awarded 'F' grade and students without having the required minimum attendance of 80 per cent will not be allowed to write the final examination and they will be awarded 'E' grade. Students who secure 'F' grade should appear for re-examination in the subsequent semester.
- If a student secured 'E' grade, he/she has to re-register and attend the course again during the next academic year.

9.4. Minimum GPA Requirement

A Ph.D student to continue his/her studies in the University, should maintain certain minimum Average Grade Point prescribed here under:

- Earn a Grade Point of 7.00 for a pass in each subject.
- For purpose of continuing as a student in the university, a candidate is required to earn an Overall Grade Point Average of not less than 7.50 at the end of each semester
- A Ph.D. student may repeat the course(s) in which he/she gets a Grade point below 7.50 and above 7.0 to improve the OGPA.

9.5. Re-Examination

Re-examination is permitted only for the final theory and practical examinations. The students who secure 'F' grade are permitted to write the re-examinations as and when conducted with the permission of university. The re-examination fee as prescribed by university per course is to be paid on or before the prescribed date. A student is permitted to write the final theory and practical examinations only two times during the course period of three years excluding the regular final examination. In the event of a student who fails to secure a pass in the two re-examinations permitted, he/she has to re-register for the course along with juniors. The marks secured in mid semester examination will be retained and the student should produce the practical record during re-examination. The registration for the re-examination shall be done after mid-semester examination on the date specified by the Director, CARE. Each registration is considered as an attempt even if the student absents for the examination.

9.6. Return Of Valued Answer Papers

The valued answer papers of mid-semester shall be shown to the students after the examination. Discrepancies if any, in awarding marks, the student can approach the teacher concerned immediately for rectification. The answer paper should be retained with the course teacher for six months and then disposed off. Evaluated final theory papers have to be retained up to six months by the Director, CARE after the conduct of examination and then disposed off.

10. CREDIT SEMINAR

Seminar is compulsory for all students and each student should register and present two seminars each with 0+1 credits. A student can register only one seminar in a semester and only after successful completion of the first seminar the student is permitted to register for the second seminar.

10.1. Credit Seminar Topic

10.1.1 The seminar topic should be only from the major field and should not be related to the area of thesis research.

10.1.2 The seminar topics are to be assigned to the students by the research supervisor in consultation with HOD within three weeks after commencement of the semester.

10.1.3. Under the guidance and supervision of the research supervisor of the RAC, the student should prepare a seminar paper containing not less than 50 typed and printed pages with a minimum number of 75 references covering the recent 10 years time after reviewing all the available literature and present the seminar after completion of 80% attendance in the semester in the presence of the HOD, RAC, staff and post-graduate students of the concerned department.

10.1.4. The circular on the presentation of the seminars may be sent to other Departments to enable those interested to attend the same.

10.1.5. The research supervisor will monitor the progress of the preparation of the seminar and correct the manuscript. The student will submit 2 copies of the corrected manuscript to the HOD through chairman before presentation.

The student will incorporate the suggestions and carry out corrections made during the presentation and resubmit three fair copies to the HOD (one to Dept. library, the second to the research supervisor and the third for student) within 15 days after presentation.

10.1.6. The performance of the student in the credit seminar will be evaluated and grade point awarded by the HOD along with the RAC for 100 marks. Grade Point may be given based on the following norms:

| Details | Marks |
|--|-------|
| Coverage of literature | 40 |
| Presentation | 30 |
| Use of audio visual aids | 10 |
| Capacity to participate in discussion and answer the questions | 20 |
| Total | 100 |

11. QUALIFYING EXAMINATION

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

11.1. Minimum requirement for Qualifying Examination

The students who have completed all the courses and earned a grade point average of not less than 7.5 will be permitted to appear for the qualifying examination. Students who do not satisfy these requirements shall not be permitted to take up the qualifying examination. The qualifying examination will be conducted after the completion of course work.

11.2. Selection of Examiner

A panel of five external examiners for qualifying examinations shall be given by the RAC in consultation with HOD before three months of the date of completion of the student's course work to the Director, CARE. One of them will be appointed as external examiner.

11.3. Written Examination

The written examination consists of two papers covering major and minor subjects only. The Director, CARE will conduct the examination by obtaining the question paper from Head of Department to be prepared in consultation with the course teachers concerned.

The question paper for the written examination will be of 3 hours duration and each question (Essay type) need not be restricted to any particular topic in a course but it should be a comprehensive covering of each unit of the syllabus of each course. The written examinations will be conducted at the same time in all disciplines. The answer papers will be evaluated by the research supervisor and Head of the Department or a senior faculty nominated by the Head of the Department. Qualifying marks for passing the examination will be 60. The viva-voce will be conducted by the external examiner after the candidate passes the qualify examination.

11.4. Qualifying viva-voce Examination

The RAC shall conduct the qualifying viva-voce examination with one external member who shall be a specialist in the subject from outside the university

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

11.6. Communication of Results of Qualifying Examination

The research supervisor shall act as chairman for the examination committee and shall be responsible for communicating the results of the examination to the Controller of Examination through HOD in the prescribed format.

11.7. Failure / Absence in Qualifying Examination

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

If the students fail in the qualifying examination, he / she is not permitted to register for further research credits.

12. THESIS RESEARCH

12.1. Selection of Topic

The thesis research for the Ph.D. degree should be of the nature of a definite contribution to the subject and the results should be of sufficient importance to merit publication. The findings should have some practical utility or should lead to theoretical contribution. The thesis shall be on a topic falling within the field of the major specialization and shall be the result of the student's own work. A certificate to this effect duly endorsed by the major advisor shall accompany the thesis.

12.2. Research Proposal

The research scholars shall present their broad area of research and submit a proposal to the Research Advisory Committee at the end of the first semester. The

research proposal has to be presented by the student in a meeting organized by the Head of the department to get the opinion / suggestion of the scientists of the department for improving it. Three copies of the research proposal in the prescribed format should be sent to the Director (CARE) through the Head of the Department for approval

The distribution of research credit will be as follows

| Semester | Credit Hours |
|--------------|--------------|
| I Semester | 0+1 |
| II Semester | 0+2 |
| III Semester | 0+12 |
| IV Semester | 0+12 |
| V Semester | 0+9 |
| VI Semester | 0+9 |
| Total | 0+45 |

The total research credits for PT and EXT candidates should be distributed in all the eight semesters as advised by RAC.

12.3. Evaluation of Thesis Research

After assigning the research problem, for each semester, the student has 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 has to be given to the student for carrying out the work during the semester.

12.3.1. Attendance register must be maintained in the Department by HOD for all the students to monitor whether the student has 80% of attendance in research.

12.3.2. The student has to submit his/her research observation note book to the research supervisor who 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.

12.3.3. After completion of 80% attendance for research and on or before the last day of the semester, the research Scholars, both full time and part time, shall submit Progress Reports in the prescribed format (Annexure-3) duly endorsed by the Research Advisory Committee to the Director, CARE until they submit their synopsis.

12.3.4 Failure to submit the progress reports shall entail automatic cancellation of registration.

12.3.5 The minutes of the meeting of the Research Advisory Committee along with enclosures will be sent to the Director, CARE.

12.3.6 The review meetings of the RAC may also be conducted through video conferencing or internet chat if the candidate or the Research Supervisor is in a foreign country.

12.3.7 Candidates who are recipients of fellowships such as JRF/SRF directly from any of the funding agencies/ shall send the progress reports and the utilization certificates in the format prescribed by the respective funding agency through proper channel.

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

SITUATION – I

The student, has completed the research credits as per the approved programme and awarded SATISFACTORY by the RAC. Under the said situation the student can be permitted to register for fresh research credits in the subsequent semester. If the student is awarded UNSATISFACTORY, he/she has to re-register the same block of research credits in the subsequent semester.

SITUATION – II

The student who has not secured the minimum attendance of 80 percent shall be awarded grade E. The student has to re-register the same block of research credits for which 'E' grade was awarded earlier in the following semester with prior permission. Until

the completion of reregistered credits, the student should not be allowed to register for fresh (first time) research credits.

SITUATION – III

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

- a) Failure of crop
- b) Non-occurrence of pests or disease or lack of such necessary experimental conditions.
- c) Non-availability of treatment materials like planting materials chemicals, etc.
- d) Any other impeding / unfavourable situation for satisfying the advisory committee.

Under the said situations grade EE should be awarded.

In the mark list, it should be mentioned that E grade or EE grade was awarded due to 'lack of attendance' or 'want for favourable experimental conditions'.

SITUATION – IV

When the student failed to complete the work even in the 'second time' registration, the student will be awarded UNSATISFACTORY and in the mark list the 'second time' should be mentioned.

For the registration of research credits for the third time, permission has to be obtained from the Dean based on the recommendation of the RAC, and HOD. Permission for registration for the fourth time shall be given only by University based on the recommendation of the RAC, HOD and Dean, Faculty of Agriculture.

13. SUBMISSION OF THESIS

The research credits registered in the last semester should be evaluated only at the time of the submission of thesis, by the RAC. Students can submit the thesis at the end of the final semester. If a student has completed the thesis before the closure of the final semester, the research supervisor can convene the RAC meeting and take decision on the submission of the thesis, provided the student satisfies 80 per cent attendance requirement. The candidate shall be allowed to submit his/her thesis after the completion of stipulated period. A grace period of 30 days may be allowed to submit the thesis after the prescribed duration. If the thesis is not submitted even after the grace period, the student shall pay the tuition fee for the year.

If a student is not able to submit the thesis within the grace period, the student has to re-register for the credits in the forthcoming semester. The student who re-registers the credits after availing of the grace period will not be permitted to avail of grace period for the second time. The Head of the Departments can sanction the grace period based on the recommendation of advisory committee and a copy of the permission letter along with the receipt for payment of fine should accompany the thesis while submission

Five copies of the thesis (in the approved format) shall be submitted together with the submission fee not later than three months after the submission of the synopsis. No dues certificates from the Department and Central Libraries, Hostel, Stores, etc. must be submitted with the thesis copies. The Research Supervisor shall forward the thesis copies with the enclosures to the Director, CARE through the HOD and the Dean. A soft copy of the thesis in PDF format as prescribed by Shodhganga, shall also be submitted.

The Ph.D scholars have to publish a minimum of two research papers in Scopus / Web of Science indexed journal. The synopsis will be accepted for processing only after showing evidences for publications of 2 such articles.

The soft copy of the thesis shall be checked for plagiarism using Turnitin software. Beyond the percentage of reproduction prescribed by UGC will not be accepted for evaluation.

13.1 Pre-submission Presentation

- 1. The pre-submission presentation of the thesis is a requirement to enrich the scholar and to fine tune his/her research presentation**
- 2. This presentation shall be conducted before the submission of the synopsis in the presence of the RAC, Supervisor/Co-Supervisor, Faculty members, Research Scholars, M.Phil., and /or P.G. Students.**
- 3. The scholar is expected to present the first draft of the research work or explain the findings/problems faced.**
- 4. The gathering may suggest ideas/references to be consulted/suggestions to improve the work and so on.**
- 5. A report on this event along with an attendance sheet shall be forwarded by the Research Supervisor with the endorsement of the RAC and HOD to the Director, CARE.**

13.2 Submission of Synopsis

- 1. The submission of synopsis may be permitted 3 months before the completion of required duration on successful completion of course work**
- 2. The Research Scholar shall submit 3 copies of the synopsis approved by the Research Advisory Committee along with a soft copy to the Director, CARE through the Research Supervisor, the HOD and Dean of the respective Faculty. Guidelines for the preparation of the synopsis are appended in Annexure -4**
- 3. Name of the candidate and name of the supervisor shall not be mentioned anywhere in the synopsis; enrolment number of the candidate alone shall be given. A model cover page for a synopsis is given in Annexure – 5**

13.3 Guidelines for Preparation of Thesis

- 1. The thesis shall not exceed 250 pages excluding the Bibliography, Appendices, etc. If it exceeds the specified number of pages, the Research Supervisor should write to University with the reasons and get prior approval from the University. The candidate shall pay a penalty for the excess number of pages as decided by the Deans Committee. The thesis should be in A4 size. The specification for the preparation of the thesis are given in Annexure-7. A model cover page for a thesis is given in Annexure -8.**
- 2. The thesis shall be typed on both sides of the page in order to save paper and postage**
- 3. The thesis shall contain a Certificate from the guide (Annexure-9) 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 guide indicating the extent to which the thesis represents independent work on the part of the candidate should also be made.**
- 4. The thesis shall also contain a Declaration by the candidate (Annexure -10) 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.**

14. VALUATION OF THE THESIS Panel Of Examiners

The thesis submitted in partial fulfillment of the Ph.D. degree shall be evaluated by two external experts one from within the country and the other from outside the country appointed by the Vice-Chancellor on the recommendation of the research supervisor of the RAC, HOD and Dean. They shall be chosen from a panel of at least five names of specialists separately from within the country and outside the country in the particular field, suggested by the research supervisor. The external experts shall send their evaluation reports of the thesis directly to the Director, CARE along with the copy of the evaluated thesis. The Director, CARE on receipt of the reports from the two examiners will

send them to the concerned guide who is the convener of viva-voce board. The guide will send the consolidated report with his remarks to the Director, CARE through the Head of the Department. On the satisfactory reports of the evaluation, viva-voce examination will be arranged.

After a student's thesis for Ph.D. degree is evaluated as indicated above, the thesis shall be finally accepted for the award only after the student satisfactorily completes a final viva-voce examination. The Viva-Voce board comprises the student's RAC with the addition of the external examiner who valued the thesis, and the HOD. If the HOD happens to be the research supervisor, the Dean, Faculty of Agriculture will nominate a senior member of the staff of the concerned Department as a member. In case of external candidates, the co-supervisor will also serve as a member of the viva-voce board. The candidate is expected to defend the thesis at the viva-voce examination. The degree shall be awarded on the unanimous recommendation of the examining committee as satisfactory with regard to the thesis and the performance of the student in the final oral examination. The recommendation of the committee shall be forwarded to the Director, CARE by the research supervisor through HOD and Dean which shall be signed by all members of the committee and the external examiner. A candidate who is not successful (unsatisfactory) at the viva -voce examination will be permitted to undergo the viva voce examination again within a period of three months.

14.2. Revision and Resubmission of Thesis

i. If an examiner recommends change / further work, the thesis will be referred to the same examiner after compliance for his opinion. In case of rejection by any one of the examiners, the thesis will be sent to another examiner and his / her recommendation will be final.

ii. If the thesis is recommended to be revised by one or both examiners, the points of revision will be indicated clearly in the report. The necessary correction should be carried out, and the revised version should be sent to the concerned examiner(s). If the examiner(s) is / are still not satisfied with the revised version, the thesis will be rejected. If the thesis is accepted by the examiners (Evaluation), Viva-Voce examination will be conducted by the viva-voce board.

14.3. Re-registration and Submission of Thesis

The minimum of 80% 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 of 3 or 4 years.

14.4. Extension of Time

1. Research scholars who do not submit the thesis within the stipulated period as per full-time/part-time/external mode should apply for extension of time three months before the completion of 3 or 4 years. Extension of time and the fees to be paid will be considered by the Deans Committee, if the extension is duly recommended by the RAC, Head of the Department, and the Dean of the Faculty, such candidates will be eligible for extension of time for a maximum period of two years.
2. The scholar will have to enroll as fresh candidates if he/she fails to submit the thesis within the maximum extension period of three years when granted.
3. If a scholar requires a few more months after the expiry of the maximum extension period of two years for the submission of the thesis as per the evaluation of the RAC, duly recommended by the Head of the Department and the Dean of the Faculty, as an exceptional case, the Deans committee may consider for re-registration to enable the scholar to submit the thesis. In any case, the time granted shall not exceed six/ twelve months.

14.5. Number of Chances

A candidate will not be permitted to submit a thesis for the degree on more than two occasions. However, it will be open to the syndicate, if the Board of Examiners so recommend, to permit the candidate to submit a thesis on a third occasion. Also, he/she will not be permitted to appear for the viva-voce examination on more than two occasions.

15. DISCONTINUANCE AND READMISSION

15.1. Students admitted to the PhD degree who discontinue their studies before completing the degree with written permission from the University may be re-admitted to the degree programme, provided that the student should have completed the course work before such discontinuance. However the period of such discontinuance should not exceed five years for Ph.D. Degree from date of admission.

15.2. After completion of course work and qualifying examination, a student is eligible to discontinue temporarily his research program only once within 5 years for PhD program. If the discontinuation period exceeds two semesters, the student has to forego the research credits already registered and register afresh with revised program. In the case of field experiments or laboratory experiments in which continuity is essential for research and if a student temporarily discontinues in the middle without completing the experiments, then the entire experiment should be repeated even if the discontinuation period does not exceed two semesters.

15.3. A student joining the studies, after discontinuation should pay the fees of the existing semester.

16. PUBLICATION OF THE THESIS

The thesis, whether approved or not, should not be published in full or abridged form without the permission of the Syndicate, which may grant permission for the publication under such conditions as it may impose.

17. Each Department should maintain a list of theses produced so far with the abstract of the same.

**DEPARTMENT OF HORTICULTURE
GHOR 81 Ph.D. (Horticulture)**

Programme Outcome

PO1 -In-depth knowledge of literature in the specialised area of research.

PO2 -Apply theories, methodologies and techniques to address fundamental research problems.

PO3 -Creativity and originality in planning and executing research independently.

PO4 -Critical thinking, problem solving and evaluation of published work.

PO5 -Ability to formulate and test novel hypotheses.

PO6 -Develop practical research skills and expertise in state-of-the art techniques in research.

PO7 -Effective scientific writing and oral presentation skills.

PO8 -Collegiality in a research setting with people from diverse backgrounds as leaders/mentors/team members.

PO9 -Ethical principles in conducting and reporting research.

PO10 -Life-long commitment to expanding the frontiers of knowledge in a specialised field.

Programme Specific Outcome

PSO1- The Scholar will acquire knowledge on crop improvement, production technologies, Biotechnology and post harvest technologies pertaining to Horticultural crops with special reference to advancements in research.

PSO2- The scholar will gain skill in approaching research problems and define research methodology for problem solving research in the field of Horticulture.

PSO3- The scholar will able to do individual research works in Horticultural crops

PSO4- The scholar will become eligible to work in research programmes offered by National and International organizations and in teaching horticultural science.

**DEPARTMENT OF HORTICULTURE
GHOR-81 : Ph.D. HORTICULTURE
DISTRIBUTION OF COURSES**

| Course Code | Course Title | Credit hours (Theory + Practical) |
|--|--|--|
| Major Courses (Any two in I sem) & (Any one in II sem) | | |
| Major Courses - Common | | |
| HOR 811 | Advances in growth regulation and stress management of horticultural crops | 2+1 |
| HOR 812 | Advances in breeding of horticultural crops | 2+1 |
| HOR 813 | Environmental horticulture | 2+1 |
| HOR 821 | Advances in biotechnology of horticultural crops | 2+1 |
| HOR 822 | Advances in nutrient management of horticultural crops | 2+1 |
| HOR 823 | Advances in post harvest management of horticultural crops | 2+1 |
| | Sub Total | 6+3=9 |
| Major Courses - Area of Specialisation (Any One per semester) | | |
| HOR 814 | Advances in crop improvement of fruits | 2+1 |
| HOR 815 | Advances in crop improvement of vegetables | 2+1 |
| HOR 816 | Advances in crop improvement of flowers | 2+1 |
| HOR 817 | Advances in crop improvement and production technology of spices and plantation crops | 2+1 |
| HOR 824 | Advances in production technology of fruit crops | 2+1 |
| HOR 825 | Advances in production technology of vegetable crops | 2+1 |
| HOR 827 | Advances in production technology of flower crops | 2+1 |
| HOR 828 | Advances in crop improvement and production technology of medicinal and aromatic crops | 2+1 |
| | Sub Total | 4+2=6 |
| | Major Courses total | 10+5=15 |
| HOR 826 | *Minor course (Two courses - One in each semester) MOOC (One in second semester) | 4+2=6 2+0=2 |
| | Sub Total | 6+2=8 |
| HOR 081, 082 | Credit Seminar (Two-one in each semester) | 0+2=2 |
| COM811 LIS 812 STA821 | Supporting courses Advances in computing applications Advances in agricultural information retrieval Advances in design of experiments | 0+1 0+1 2+1 |
| | Sub Total | 2+3=5 |
| HOR 801,802, 803,804 | Research | 0+45=45 |
| | Grand Total | 18+57=75 |

* Minor course must be from other Disciplines

**DEPARTMENT OF HORTICULTURE
GHOR 81 Ph.D. HORTICULTURE
SEMESTER WISE DISTRIBUTION**

| Semester-I | | |
|--|---|--|
| Course Code | Course Title | Credit hours (Theory + Practical) |
| Major Courses(Any two) | | |
| HOR 811 | Advances in growth regulation and stress management of horticultural crops | 2+1 |
| HOR 812 | Advances in breeding of horticultural crops | 2+1 |
| HOR 813 | Environmental horticulture | 2+1 |
| Major Courses -Area of Specialisation (Any One) | | |
| HOR 814 | Advances in crop improvement of fruits | 2+1 |
| HOR 815 | Advances in crop improvement of vegetables | 2+1 |
| HOR 816 | Advances in crop improvement of flowers | 2+1 |
| HOR 817 | Advances in crop improvement and production technology of spices and plantation crops | 2+1 |
| | Minor course | 2+1=3 |
| | Supporting course | |
| COM 811 | Advances in computing applications | 0+1 |
| LIS 812 | Advances in Agricultural Information Retrieval | 0+1 |
| HOR 801 | Research | 0+1=1 |
| HOR 081 | Seminar | 0+1=1 |
| | Sub Total | 8+8=16 |
| Semester-II | | |
| Major Courses (Any one) | | |
| HOR 821 | Advances in bio-technology of horticultural crops | 2+1 |
| HOR 822 | Advances in nutrition management of horticultural crops | 2+1 |
| HOR 823 | Advances in post harvest management of horticultural crops | 2+1 |
| Major Courses -Area of Specialisation (Any One) | | |
| HOR 824 | Advances in production technology of fruit crops | 2+1 |
| HOR 825 | Advances in production technology of vegetable crops | 2+1 |
| HOR 827 | Advances in production technology of flower crops | 2+1 |
| HOR 828 | Advances in crop improvement and production technology of medicinal and aromatic crops | 2+1 |
| | Minor course | 2+1=3 |
| HOR 826 | MOOC | 2+0=2 |
| | Supporting course | |
| STA 821 | Advances in design of experiments | 2+1 |
| HOR 802 | Research | 0+2=2 |
| HOR 082 | Seminar | 0+1=1 |
| | Sub Total | 10+7=17 |
| Semester-III | | |
| HOR 803 | Research | 0+12=12 |
| Semester-IV | | |
| HOR 804 | Research | 0+12=12 |

| | | |
|--------------------|-----------------|-----------------|
| Semester-V | | |
| HOR 805 | Research | 0+9=9 |
| Semester-VI | | |
| HOR 806 | Research | 0+9=9 |
| Grand Total | | 18+57=75 |

Minor course must be from other Disciplines

HOR 811 ADVANCES IN GROWTH REGULATION AND STRESS MANAGEMENT OF HORTICULTURAL CROPS (2+1)

Learning Objectives

- This course provides basic information's on physiological mechanisms of growth, flowering and development of fruits and seeds, besides elaborating the mechanisms of abscission, senescence and fruit ripening.
- To impart basic knowledge on the natural phytohormones and their specific functions in controlling the growth and developments
- To understand the physiology of canopy management flowering, fruit setting and seed development in horticultural crops

Theory

Unit-I Introduction

Growth and development –definition- parameters of growth and development- growth dynamics-morphogenesis-physiology and biochemistry of germination-bulb, tuber and bud formation-environmental impact on growth and development-effect of light-photoperiodism-temperature-heat units-thermoperiodism.

Unit-II Phases of development

Dormancy-seed, bud - factors influencing dormancy-breaking dormancy-phases of development-canopy development-physiological basis of training and pruning-physiology of flowering – earliness - photoperiodism and flowering, vernalization and flowering, phytochrome-concepts of flowering stimulus-induction and modulation of flowering-fruit set-fruit growth-climacteric and non- climacteric fruits-seedlessness -fruit drop-control-fruit ripening.

Unit-III Plant growth regulators

History, isolation, structure, bio-synthesis, mode of action, metabolism and physiological aspects of Auxins, Gibberellins, Cytokinins, Ethylene, Abscissic acid, Brassinosteroids, Triacntanol, growth inhibitors, Morphactins- growth retardants and growth substances of plant and microbial origin.

Unit-IV Growth manipulation and senescence

Chemical manipulation of growth and development of horticultural crops- molecular and genetic approaches in plant growth and development –senescence-signals of senescence- chemical and physiological regulation of senescence–abscission

Unit-V Abiotic stress management

Major abiotic stress factors-effects –tolerance-management of stress factors *viz*, salinity, acidity, alkalinity, low and high temperatures-frost-heavy metals-water logging-wind-nutrient deficiencies and physiological disorders.

Current Stream of Thought

Practical

Growth analysis of various forms of horticultural species-growth modification experiments-experiments on physiological and biochemical aspects of germination-investigation on seed dormancy factors-breaking of dormancy-experiments on identifying causes for flowering stimulus, vernalization - photoperiodism and flowering-experiments on induction of seedlessness- flower and fruit drop-isolation of hormones-bioassay and Immuno assay techniques - methods of analysis of hormonal effects-physical and chemical

manipulation of growth- experiments on major abiotic stress factors on growth and development of horticultural crops.

Lecture schedule

- 1. Growth and development: definitions and parameters of growth and development.**
- 2. Principles of growth dynamics and morphogenesis.**
- 3. Growth curves:stages and different patterns of growth curves of horticultural crops.**
- 4. Growth analysis in horticultural crops (CGR, RGR, NAR, LAI, LAR, HI in horticultural crops).**
- 5. Canopy development and plant density with respect to crop productivity.**
- 6. Solar radiation concept and techniques for harvesting solar radiation for crop productivity.**
- 7. Physiology and biochemistry of seed germination**
- 8. Physiology and biochemistry of dormancy : seed and bud dormancy**
- 9. Physiology of bud breaking and methods of overcoming dormancy in horticultural crops**
- 10. Effect of vernalisation, temperature, heat units and thermoperiodism on developmental physiology.**
- 11. Physiology of flowering : florigen and anti-florigen concepts with special reference to horticultural crops.**
- 12. Physiology of flowering: floral induction theories/models: ABC model, photoperiodism and vernalisation.**
- 13. Effect of light and photoperiodism on developmental physiology**
- 14. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of auxins.**
- 15. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of gibberellins.**
- 16. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of cytokinins.**
- 17. Mid -semester examination.**
- 18. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of ethylene.**
- 19. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of brassinosteroids and morphactins**
- 20. Physiology of flowering : factors affecting flowering and different stages of flowering**
- 21. Biosynthesis, translocation, physiological role in cell level, basic functions and mechanism of action of inhibitors and retardants**
- 22. Role of bio stimulants in crop growth and development: seaweed extract, humic acid, fulvic acid, chitosan and growth promoting microorganisms.**
- 23. Physiological and biochemical basis of training and pruning.**
- 24. Source and sink relationship and concepts (carbon partitioning, sucrose synthesis, phloem loading and transportation).**
- 25. Physiology of fruit set and development with a special reference to chemical regulation of fruit set.**
- 26. Physiological basis of unfruitfulness, fruit drop and fruit thinning**
- 27. Physiological and biochemical basis of ripening and post harvest physiology of horticultural crops**
- 28. Physiological and biochemical basis of tuber and bulb formation with special reference to growth regulation for tuber and bulb yield.**

29. Physiological and biochemical basis of senescence with special reference to molecular and genetic approaches in plant senescence
30. Concepts of stress physiology: stress, eustress, distress, stress tolerance, resistance, avoidance
31. Stress responses of plants at cellular and molecular level.
32. Causes, effects and methods of overcoming heat and low temperature stress.
33. Causes, effects and methods of overcoming water deficit and flooding stress.
34. Causes, effects and methods of overcoming salinity stress.

Practical schedule

1. Estimation of growth parameters for analyzing the growth - estimation of leaf area index.
2. Estimation of growth parameters for analyzing the growth – DMP and growth rates.
3. Evaluation of photosynthetic efficiency of horticultural crops under different environments.
4. Visit to arid, subtropical and temperate horticultural zones to identify growth and development pattern of different horticultural crops.
5. Studies on mechanism breaking of dormancy by stratification in seeds.
6. PGR experiments on seeds, tubers and bulbs -breaking of dormancy.
7. Hormone assays (Auxin)
8. Experiments on growth regulator functions - rooting of cuttings and herbicidal effect.
9. Experiments on growth regulator functions - fruit ripening in climacteric and non-climacteric fruits.
10. Experiments on growth regulator functions – senescence.
11. Experiments on growth regulation by pruning, pinching, defoliation and disbudding in horticultural crops .
12. Experiments on growth regulator functions – fruit thinning, overcoming fruit drop and unfruitfulness.
13. Experiments on growth regulator functions – post harvest losses in horticultural crops and post harvest treatments for shelf life.
14. Growing of plants in sand culture to study the effect of drought stress.
15. Growing of plants in artificially salinized soil in pots to study the effect of salt stress.
16. Effect of osmotic and ionic stress on seed germination and seedling growth
17. Estimation of proline content in stress and normal condition in crops.

Course Outcome

CO1- Develop knowledge about the functions of various natural growth hormones in the regulation of growth and development processes.

CO2-Develop adequate knowledge about the application of synthetic growth hormones for the manipulation of various physiological processes.

CO3- Develop the ability to analyse the growth processes with physiological reasoning.

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| CO2 | X | X | X | | X | X | X | X | X | X | X | X | X | X |
| CO3 | X | | X | X | X | X | X | X | X | X | X | X | X | X |

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HOR 812 ADVANCES IN BREEDING OF HORTICULTURAL CROPS (2+1)

Learning Objectives

- The present course enables the students to understand the basic and principles of modern plant breeding and learns to integrate the conventional techniques.
- To identify the methods that contributes towards greater efficacy in the selection processes and in the development of new varieties.
- This course also helps to design a breeding programme for a given crop species for the conditions of the need according to specific objectives.

Theory

Unit-I Pre requisites for crop improvement

Collection, conservation and domestication of horticultural crops – origin of species – centres of diversity – bio diversity of horticultural crops – gene bank – collection, conservation and utilization of genetic resources – field gene bank – cryo preservation.

Unit-II Scope for crop improvement

Specific objectives for breeding of horticultural crops – different breeding systems, methods of breeding for annual and perennial horticultural crops – male sterility – incompatibility – synthetics and composites – development of ideotypes – problems of breeding perennial horticultural crops.

Unit-III Breeding methods - I

Heterosis breeding – exploitation of hybrid vigour in horticultural crops plant Introduction – domestication and adoption – selection methods – polyploidy and mutation breeding – wide hybridization.

Unit-IV Breeding methods - II

Breeding for quality processing of fruits and vegetables – resistance to pests and diseases – resistance to abiotic stresses – criteria for selection – screening for abiotic stresses – criteria for selection and screening.

Unit-V Applications of biotechnology

In-vitro breeding – genetic engineering – use of biotechnological tools for crop improvement – molecular characteristics of horticultural crops – plant variety protection act.

Current Stream of Thought

Practical

Floral biology – study of selfing and crossing techniques, study of pollen morphology and viability, evaluation of hybrids and estimation of heterosis – selection in segregating population – clonal evaluation – induction of mutants and polyploids – hybrid seed production.

Lecture schedule

1. Origin of species, centres of diversity.
2. Bio diversity conservation, agencies, gene bank.
3. Collection, conservation and utilization of genetic resources.

4. Field gene bank, cryopreservation, pollen preservation.
5. Objectives and scope of plant breeding in horticultural crops.
6. Breeding systems, methods of reproduction in horticultural crops.
7. Modes of reproduction, mechanisms of pollination control, sterility and incompatibility systems.
8. Crop improvement methods in annual horticultural crops- introduction and selection.
9. Crop improvement methods in annual horticultural crops- hybridization.
10. Crop improvement methods in annual horticultural crops- pedigree breeding.
11. Crop improvement methods in annual horticultural crops- bulk and single seed descent methods.
12. Crop improvement methods in annual horticultural crops- mass selection, recurrent and reciprocal recurrent selection.
13. Crop improvement methods in annual horticultural crops- back cross breeding.
14. Crop improvement methods in annual horticultural crops - heterosis breeding, exploitation of hybrid vigour.
15. Development of F₁ hybrids – methods and procedures in various annual horticultural crops.
16. Synthetics and composites.
17. Mid-semester examination
18. Mutation breeding in annual horticultural crops.
19. Ploidy breeding in annual horticultural crops.
20. Objectives, scope and problems in breeding of perennial horticultural crops.
21. Perennial horticultural crop improvement through introduction and clonal selection.
22. Perennial horticultural crop improvement through hybridization.
23. Perennial horticultural crop improvement through mutation breeding.
24. Perennial horticultural crop improvement through ploidy breeding.
25. Breeding for quality traits – improvement of pigment concentration in horticultural crops.
26. Breeding for quality traits – improvement of shelf life.
27. Concepts of breeding for resistance to biotic stresses.
28. Methods of breeding for resistance to biotic stresses in horticultural crops.
29. Concepts of breeding for resistance to abiotic stresses in horticultural crops.
30. Methods of breeding for resistance to abiotic stresses in horticultural crops.
31. Somatic hybridization.
32. Molecular markers, genetic fidelity confirmation and marker assisted selection.
33. Genetic transformation methods.
34. Emerging concepts and applications in horticultural crop improvement.

Practical schedule

1. Study of floral biology of selected horticultural crops.
2. Study of pollen production and fertility
3. Practices in hybridization of selected perennial and annual horticultural crops.
4. Crossing programmes – diallel.
5. Characterization and documentation of germplasm.
6. Estimating genetic diversity- interpreting cluster analysis and dendrogram.
7. Selection procedures in annual horticultural crops
8. Handling segregating population
9. Clonal evaluation and plus tree identification.
10. Estimation of PCV, GCV and heritability
11. Practices in F₁ seed production
12. Estimation of heterosis
13. Estimation of stability parameters
14. Practices in *in vivo* mutation breeding

15. Varietal description of annual and perennial horticultural crops.
16. Practices in polyploidy breeding of annual horticultural crops.
17. Practices in polyploidy breeding of perennial horticultural crops.

Course Outcome

The scholar will be able to

CO1- Understand the differences between modern and conventional methods of breeding.

CO2- Able to design a breeding programme for a crop according to specific objectives.

CO3- Incorporate Biotechnological Tools And Molecular Breeding Techniques For Crop

Improvement

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|----------|----------|----------|----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|
| CO1 | X | | X | X | X | X | X | X | X | X | X | | X | |
| CO2 | X | X | X | X | X | X | X | X | X | X | X | | X | |
| CO3 | X | X | X | X | X | X | X | X | X | X | X | | X | |

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HOR 813 ENVIRONMENTAL HORTICULTURE (2+1)

Learning Objectives

- To update knowledge on the recent advances in the impact of environmental constraints of horticultural crop production,
- To study the ecological issues related to horticultural crops
- To collect knowledge regarding sustainable horticulture, ecosystem, pollution and environmental protection.

Theory

Unit-I Ecology and Horticulture

Environmental complex, interaction of ecological factors in horticultural crop production, interaction of physiographic factors in horticultural crop production.

Unit-II Global warming and its impact on Horticultural Crops

Global warming - carbon trading, role of green house gases, elevated CO₂ and its impact on productivity of horticultural systems - forest ecosystem and its evolution to a hort - ecosystem

Unit-III Environmental Issues on Horticultural aspects

Phytogeography, changes in land use pattern and its impact on horticultural crop production - horticultural aspects of environmental issues - soil, water, air and noise pollution.

Unit-IV Natural resource management in Hortisystems

Natural resource management in hortisystems – natural resources; atmosphere, water, land and bio resources, renewable and non renewable energy management- alternate farming systems.

Unit-V Organic horticulture

Organic Horticulture – scope and constraints – principles and components - NPOP standards and certification - environmental policy and legislation in India - NBA International treaties and summit - water, soil and air quality standards.

Current Stream of Thought

Practical

Productivity assessment of various ecosystems -assessment of air pollution on crop plants and tree species – effect of waste water on crop plants – purification of industrial waste water –estimation of leaf litter-waste recycling-composting — assessment of land use changes and its impacts in horticultural systems – chlorophyll stability index – photosynthetic rate and biological efficiency –residual analysis.

Lecture Schedule

1. Environment - components , complex
2. Ecological factors in horticultural crop production
3. Interaction of ecological factors in horticultural crop production
4. Physiographic factors in horticultural crop production
5. Interaction of physiographic factors horticultural crop production
6. Global warming
7. Carbon trading
8. Role of green house gases, elevated CO₂ and its impact on productivity of horticultural systems
9. Habitat ecology
10. Changes in habitats
11. Impact of habitat changes on horticultural production
12. Forest ecosystem and its evolution to a hort - ecosystem
13. Landscape ecology
14. Urban woodlands
15. Environmental issues and Horticultural aspect of environmental issues
16. Air soil water and noise pollution
17. Mid semester examination
18. Phytoremediation
19. Alternative farming systems
20. Horticultural crops suitable for different ecological conditions
21. Phytogeography
22. Changes in land use pattern
23. Impact of changes in land use pattern on horticultural crop production
24. Natural resources: atmosphere, water , land and bio resources
25. Natural resource management
26. Renewable and non renewable energy management
27. Horticultural therapy
28. Therapeutic garden design
29. Scheduled events and activities related to horticultural therapy
30. Aroma therapy and its application
31. Environmental policies and legislations in India
32. International treaties and summits
33. Water soil and air quality standards
34. Environmental organizations – Biodiversity board, pollution control act

Practical Schedule

1. Productivity assessment of various eco systems
2. Assessment of air pollution crop plants and tree species
3. Effect of waste water on crop plants
4. Pacification of waste water
5. Estimation of leaf litter
6. Waste recycling
7. Composting
8. Assessment of land use changes and its impacts in horticultural systems
9. Estimation of chlorophyll stability index
10. Estimation of photosynthetic rate
11. Estimation of biological efficiency
12. Estimation of crop growth sustainability indices
13. Pesticide residue analysis
14. Fertilizer residue analysis
15. Estimation of biological contaminants
16. Designing a therapeutic garden and florist design
17. Economics of hort - eco system conservation

Course Outcome

The scholar will be able to

CO1- Differentiate the environmental factors influencing the horticultural crop production

CO2-Elucidate factors like global warming and pollution control.

CO3- Will become eligible to work in environment protection projects and research works

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | | | X | X | | X | X | X | X | | X | |
| CO2 | X | | X | X | X | X | | X | X | X | X | | X | |
| CO3 | | | X | X | X | X | | X | X | X | X | | X | |

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HOR 814 ADVANCES IN CROP IMPROVEMENT OF FRUITS (2+1)

Learning Objectives

- The present course enables the students to understand the basic and principles of modern plant breeding and learns to integrate the conventional techniques.
- To identify the methods that contributes towards greater efficacy in the selection processes and in the development of new varieties.

- This course also helps to design a breeding programme for a given crop species for the conditions of the need according to specific objectives.

Theory

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

Unit -I Breeding of tropical fruit crops - I

Mango, banana and papaya

Unit -II Breeding of tropical fruit crops -II

Guava, sapota and grapes

Unit -III Breeding of sub-tropical fruit crops -I

Citrus, pineapple, jack fruit and avocado

Unit -IV Breeding of sub- tropical fruit crops -II

Litchi, annona, ber and pomegranate

Unit- V Breeding of temperate fruit crops

Apple, pear, plum, peach, apricot and strawberry

Current Stream of Thought

Practical

Characterization of germplasm- blossom biology- estimating fertility status- practices in hybridization- ploidy breeding- mutation breeding- evaluation based on biometrical traits and quality traits- screening for resistance against biotic and abiotic stress- developing breeding programme for specific traits- visit to research stations working on tropical- subtropical and temperate fruit improvement.

Lecture schedule

1. Need and status of fruit breeding in India, study of institutes working on fruit crop improvement
2. Constraints of breeding of fruit crops, sterility, incompatibility, heterozygosity and methods suggested to overcome the hurdles in breeding
3. Scope for breeding against production constraints , yield and quality enhancement
4. Pollination problems in relevance to fruit set in the given fruit crops.

Origin and distribution, taxonomic status, related genus, species and cultivars, ideotypes, cytogenetics, genetic resources for improvement, breeding objectives, breeding systems- introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, quality and resistance breeding, biotechnological interventions, achievements and future thrust for the following crops:

5-6.Mango

7-8. Banana

9-10. Papaya

11-12.Guava

13-14. Citrus

15-16. Grapes

17. Mid-semester examination

18. Sapota

19. Pineapple

20. Jack

21 Avocado

22. Litchi

23. Annona

24. Ber

- 25. Pomegranate
- 26-27. Apple
- 28. Pear
- 29. Plum
- 30. Peach
- 31. Apricot
- 32. Strawberry
- 33 Walnut
- 34. Almond

Practical schedule

1. Scoring techniques for genomic status in banana.
2. Characterization of germplasm of banana.
3. Characterization of germplasm of papaya.
4. Study of blossom biology in mango, banana and papaya.
5. Study of blossom biology of guava, sapota, grapes.
6. Study of blossom biology of mandarin, pineapple, jackfruit, avocado and litchi.
7. Study of blossom biology of apple, pear, plum, peach, apricot and strawberry.
8. Estimation of pollen output, viability and germinability in fruit crops.
9. Practices in hybridization, ploidy breeding, mutation breeding of mango and banana.
10. Practices in hybridization, ploidy breeding, mutation breeding of papaya and sapota.
11. Practices in hybridization, ploidy breeding, mutation breeding of grapes and guava.
12. Criteria for evaluation based on biometric and quality traits in fruit crops.
13. Screening and scoring techniques for resistance against biotic stress such as viral diseases and fusarium wilt in banana and PRSV in papaya.
14. Screening techniques for resistance against abiotic stresses like salt and drought tolerance in fruit crops.
- 15-17. Visit to research institutes working on improvement of fruit crops and visit to sub-tropical research stations for studying breeding programmes.

Course Outcome

The scholar will be able to

CO1- Understand the basic methods of fruit breeding

CO2- Understand the strategies and objectives of fruit breeding

CO3- Understand the breeding procedures for stress physiology

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | X | X | X | X | X | X | X | X | X | | X | |
| CO2 | X | X | X | X | X | X | X | X | X | X | X | | X | |
| CO3 | X | X | X | X | X | X | X | X | X | X | X | | X | |

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HOR 815 ADVANCES IN CROP IMPROVEMENT OF VEGETABLES (2+1)

Learning Objectives

- The student can able to apply traditional and molecular breeding methods for the enhancement of vegetable crops.
- Interpret how plant breeding, scientific research, genetic diversity, germplasm resources and conservation, government policies, industry needs and consumer preferences can affect vegetable crop improvement programs.
- Design and present a vegetable breeding research project that meets specific short-term and long-term goals.

Theory

Breeding objectives, taxonomy, cytogenetics and applicable crop improvement the following vegetable crops

Unit-I Solanaceous and Malvaceous vegetables

Tomato, brinjal, chillies, capsicum, potato, okra

Unit-II Cucurbitaceous vegetables

All gourds, melons, pernniala cucubrits

Unit-III Root & tuberous vegetables

Carrot, radish, beetroot, tapioca, sweet potato

Unit-IV Cruciferous & fabaceous vegetables

Cabbage, cauliflower, knol khol, turnip, peas, beans

Unit-V Leafy and bulbous vegetables

Amaranthus, moringa, onion, garlic, spinach, palak

Current Stream of Thought

Practical

Modes of pollination and reproduction- pollen morphology and viability- palanological studies- selfing and crossing techniques in vegetable crops- assessment of variability- estimation of genetic distance- techniques of hybridization in vegetable crops- emasculation and hybridization- techniques of handling segregating progenies- D² analysis- heterosis and combining ability- diallel and line x tester analysis- assessment of character association- path analysis- study of superior varieties and hybrids in vegetable crops- visit to vegetable crops breeding centers and research institutes.

Lecture schedule

Origin- botany and taxonomy- genetics- cytogenetics- plant genetic resources- anthesis- pollination- fertilization mechanism- sterility and incompatibility- constraints- breeding objectives- methods and achievements in the following crops:

- 1-2. Tomato.
- 3-4. Brinjal.
- 5-6. Chilli.
7. Sweet pepper.
8. Bhendi
9. Potato.
10. Bitter gourd.
11. Ash gourd.
12. Ridge gourd.
13. Snake gourd.
14. Watermelon .
15. Muskmelon.

16. Perennial Cucurbitaceous vegetables
17. Mid -semester examination
18. Carrot, Radish
19. Beet root.
20. Tapioca
21. Sweet Potato.
22. Cabbage.
23. Cauliflower
24. Knol-khol.
25. Turnip
26. Peas.
27. Beans
28. Amaranthus.
29. Moringa.
- 30.-31 Onion.
32. Garlic
33. Spinach .
34. Palak.

Practical schedule

1. Study of pollination mechanisms, pollen morphology and viability in solanaceous vegetable crops.
2. Study of pollination mechanisms, pollen morphology and viability in cucurbits.
3. Study of pollination mechanisms, pollen morphology and viability in crucifers.
4. Assessment of variability for vegetable improvement.
5. Estimation of genetic distance – D² analysis
6. Estimation of heterosis and combining ability
7. Study of diallel and line x tester analysis
8. Study of correlation and path analysis
9. Floral biology and techniques of hybridization in solanaceous vegetables.
10. Floral biology and techniques of hybridization in leguminous vegetables.
11. Floral biology and techniques of hybridization in cucurbitaceous vegetables.
12. Practices in breeding methods of cruciferous vegetable crops.
13. Practices in breeding methods of potato, tapioca and sweet potato.
14. Practices in breeding methods of root vegetables.
15. Practices in breeding methods of onion and garlic.
16. Practices in breeding methods of moringa and amaranthus.
17. Practices in breeding methods of okra.

Course Outcome

The scholar will be able to

CO1- Understand the pollination behavior and mechanisms of vegetables

CO2-. Understand the screening techniques for improving vegetables

CO3- Know how to design breeding experiments

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | X | | X | X | X | X | X | X | X | | X | |
| CO2 | X | X | X | X | X | X | X | X | X | X | X | | X | |
| CO3 | | X | X | X | X | X | X | X | X | X | X | | X | |

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HOR 816 ADVANCES IN CROP IMPROVEMENT OF FLOWERS (2+1)

Learning Objectives

- To exploit various crop improvement techniques to attain desirable floricultural traits.
- To study about different techniques of plant breeding like introduction, selection, mutation breeding, hybridization etc. utilized for the development of new commercial varieties in floricultural crops.
- The course aims to expose the students to basic techniques of breeding used in crop improvement and their utilization for the development of new varieties.
- These techniques have been explained in an elaborative manner in the course along with suitable examples and illustrations.

Theory

Origin , distribution, genetic divergence, inheritance, breeding principles, breeding objectives, breeding methods, evolution of varieties, *in-vitro* breeding, genetic engineering, bio technological tools, specific breeding problems and achievements patents – plant variety protection act and IPR issues of the following crops.

Unit-I Breeding of flower crops - I

Rose, jasmine, chrysanthemum, nerium and crossandra.

Unit-II Breeding of flower crops – II

Tuberose , carnation, marigold, gerbera and gladiolus

Unit-III Breeding of flower Crops -III

Orchids, anthurium, dahlia and liliiums

Unit-IV Breeding of annuals

Flowering annuals –Zinnia, petunia, cosmos, dianthus pansy, aster, petunia and snap dragon

Unit-V Breeding of ornamental plants

Heliconia, hibiscus, bougranvillea, bird of paradise and other foliage- breeding of ornamentals for water scaping and xeriscaping.

Current Stream of Thought

Practical

Description of botanical features-cataloguing of cultivars, varieties and species in flowers-floral biology-selfing and crossing- evaluation of hybrid progenies-estimation of heterosis, seed production-clonal evaluation-induction of mutants- induction of polyploidy- screening of varieties for biotic and abiotic stress and environmental pollution-*in-vitro* breeding-special breeding techniques for important flower crops

Lecture schedule

Origin, distribution, breeding principles, genetic resources, genetic divergence, genetic inheritance, evolution of varieties, breeding objectives, breeding methods, specific breeding problems and achievements of the following crops:

1-3. Rose

4-6. Jasmine.

- 7-9. Chrysanthemum.
10. Nerium
11. Crossandra.
- 12-13 Tuberose
14. Carnation.
15. Marigold.
16. Gerbera
17. Mid- semester examination
18. Gladiolus
19. Orchids. Anthodium
20. Anthurium
21. Dahlia
22. Linium
23. Zinnia
24. Petunia
25. Cosmos
26. Dianthus
27. Pansy and Petunia
28. Aster
29. Snapdragon
30. Heliconia and Bird of Paradise
31. Hibiscus
32. Bougainvillea and other foliages
33. Patents and Plant Variety Protection Act and IPR issues.
34. Breeding of ornamental plants for waterscaping and xeriscaping.

Practical schedule

1. Cataloguing of cultivars, varieties and species of rose, jasmine and chrysanthemum.
2. Cataloguing of cultivars, varieties and species of marigold, tuberose and crossandra.
3. Cataloguing of cultivars, varieties and species of orchids, anthurium and gerbera.
4. Cataloguing of cultivars, varieties and species of carnation and gladioli.
5. Study of floral biology of flower crops.
6. Study of pollen production and fertility.
7. Practices in hybridization of flower crops.
8. Evaluation of hybrid progenies.
9. Experiments on hybrid seed production in flower crops.
10. Practices in ploidy breeding in flower crops.
11. Practices in induction of mutation of flower crops.
12. Practices in *in vitro* breeding of flower crops and ornamental plants.
13. Seed production techniques in flowering annuals.
14. Screening of plants for resistance against biotic stress.
15. Screening of plants for resistance against abiotic stress.
16. Screening of plants for resistance against environmental pollution.
17. Visit to Research Institutions working on improvement of flower crops, commercial flower breeding / seed production centres.

Course Outcome

The scholar will be able to

CO1- understand the basic breeding techniques

CO2- Understand the breeding procedures of important commercial flower crops

CO3- Gain knowledge of techniques of handling flower crops in a practical manner

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | X | | X | X | X | X | X | X | X | | X | |
| CO2 | X | X | X | X | X | X | X | X | X | X | X | | X | |
| CO3 | | X | | X | X | X | X | X | X | X | X | | X | |

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HOR 817 ADVANCES IN CROP IMPROVEMENT AND PRODUCTION TECHNOLOGY OF SPICES AND PLANTATION CROPS (2+1)

Learning Objectives

- To impart basic knowledge regarding the production technology of spices and plantation crops.
- To study about cropping systems, crop regulation practices of spices and plantation crops
- To gain knowledge regarding the processing techniques of spices and plantation crops
- To collect ideas of quality control management and organic production and certification of spices and plantation crops.

Theory

Unit-I Introduction

Spices and plantation crops- history and classification – area and production – Scope, importance and Future prospects -export potential – varietal wealth – genetic resources – commodity boards in development of spices and plantation crops – GAP & GMP for spices and plantation crops.

Unit-II Crop Improvement of spices and plantation crops

Introduction – botany and taxonomy- appraisal on the crop improvement in spices and plantation crops -modes of reproduction –blossom biology-mode of pollination-breeding methods- hybridization –resistance breeding -*in-vitro* breeding – genetic engineering – use of biotechnological tools for crop improvement – molecular characteristics- varieties released - plant variety protection act.

Unit-III Crop production techniques of spices

Climatic and soil requirements, propagation techniques –systems of cultivation – training and pruning – nutrition and irrigation requirements – intercropping, mixed cropping – intercultural operations –mulching – weed control – harvesting –quality control and organic certification – processing and value addition of the following crops.

Major spices- Pepper, Cardamom, Ginger, Turmeric

Tree spices - Clove, Nutmeg, Cinnamon, All spice

Seed spices Coriander, Fennel, Cumin, Fenugreek, Herbal and other spices.

Unit-IV Crop production techniques of plantation crops -I

Coffee, Tea, Rubber, Cocoa, Oil palm

Unit-V Crop Production techniques of Plantation crops -II

Coconut, Arecanut, Cashew, Palmyra

Current Stream of Thought

Practical

Characterization and evaluation of germplasm accessions- blossom biology- studies on pollen behaviour- practices in hybridization- ploidy breeding- mutation breeding- evaluation of biometrical traits and quality traits- screening for biotic and abiotic stresses- induction of somaclonal variation and screening the variants, identification and familiarization of spices floral biology anthesis fruit set selfing and crossing techniques description of varieties. salient features of improved varieties and cultivars from public and private sector- visit to National institutes for spices and plantation crops and plant genetic resource centres- genetic transformation in spices and plantation crops for resistance to biotic stress/quality improvement etc.

Lecture schedule

- 1. Role of spices and plantation crops in National economy, export potential and imports, area and production**
- 2. History and Classification of spices and plantation crops.**
- 3. Genetic resources of spices and plantation crops**
- 4. Varietal wealth of spices and plantation crops**
- 5. Commodity boards in development of spices and plantation crops**
- 6. GAP & GMP for spices and plantation crops.**
- 7. Study of botany and taxonomy of Spices**
- 8. Study of botany and taxonomy of Plantation crops**
- 9. Mode of reproduction –blossom biology-mode of pollination**
- 10. Breeding Methods in Spices and Plantation**
- 11. Hybridization technique**
- 12. Resistance breeding -*In-vitro* breeding – genetic engineering**
- 13-14. Use of biotechnological tools for crop improvement**
- 15. Plant variety protection act.**
- 16. Climatic and soil requirements, propagation techniques –systems of cultivation – training and pruning – nutrition and irrigation requirements – intercropping, mixed cropping – intercultural operations –mulching – weed control – harvesting – pruning – training -Quality control and organic certification – processing and value addition of the following crops: Black Pepper**
- 17. Mid- semester examination**
- 18. Cardamom**
- 19. Ginger**
- 20. Turmeric**
- 21. Clove & Nutmeg**
- 22. Cinnamon and all spice**
- 23-24. Seeds spices**
- 25. Herbal and other spices**
- 26. Tea**
- 27. Coffee**
- 28. Rubber**
- 29. Cocoa**
- 30. Oil palm**

31. Coconut
32. Arecanut
33. Cashew
34. Palmyra

Practical schedule

1. Scoring techniques for genomic status in coffee and tea.
2. Study of blossom biology in Coffee and tea.
3. Study of blossom biology in Cashew and Cocoa
4. Study of blossom biology in Coconut and arecanut
5. Study of blossom biology in Rubber, palmyrah and Oil palm.
6. Study of floral biology, anthesis in Black pepper, cardamom, ginger and turmeric.
7. Study of floral biology, anthesis in fenugreek, coriander, fennel and nutmeg.
8. Study of floral biology, anthesis in cinnamon, clove and celery.
9. Practices in in-vitro approaches in improvement of plantation crops.
10. Practices in in-vitro approaches in improvement of spice crops.
11. Estimation of pollen output, viability and germinability in plantation crops.
12. Estimation of pollen output, viability and germinability in spice crops
13. Practices in hybridization of fenugreek, coriander.
14. Screening techniques for resistance against abiotic stress -salt and drought tolerance in possible plantation crops.
15. Screening techniques for resistance against abiotic stress -salt and drought tolerance in possible spice crops.
16. Visit to research institutes working on important plantation crops and studying breeding programmes.
17. Visit to research institutes working on important spice crops and studying breeding programmes.

Course Outcome

The student will be able to

CO1- Gain knowledge about cropping systems adapted in spices and plantation crops

CO2- Understand processing techniques of spices and plantation crops

CO3- could able to prepare projects for establishing processing units

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|----------|----------|----------|----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|
| CO1 | X | | X | X | X | X | | | | X | X | | X | |
| CO2 | X | X | | | X | X | | | | X | X | | X | |
| CO3 | X | X | | X | X | X | | | | X | X | | X | |

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HOR 821 ADVANCES IN BIOTECHNOLOGY OF HORTICULTURAL CROPS(2+1)

Learning Objectives

- **To provide an insight into the basic principles of biotechnology**
- **To impart knowledge on various techniques of biotechnology and their applications.**
- **To impart knowledge on genetic engineering techniques**
- **To gain information regarding the molecular markers and their thrust in Horticultural biotechnology**

Theory

Unit-I Importance, history and scope of biotechnology

Scope of biotechnology – principles and concepts – history of plant tissue culture – general techniques – factors influencing organogenesis and somatic embryogenesis.

Unit-II Techniques of tissue culture -I

Callus culture – cyto differentiation – organogenesis – suspension culture – use of bio reactors and *in-vitro* methods for production of secondary metabolites – rapid clonal propagation - hardening and field transfer.

Unit-III Techniques of tissue culture -II

Organ culture – meristem , anther, pollen embryo culture, embryo rescue technique – *in-vitro* pollination and fertilization – somaclonal variation

Unit-IV: Techniques of tissue culture -III

Protoplast culture – fusion – identification of somatic hybrids – synthetic seed production - cryopreservation.

Unit-V Genetic Engineering and Molecular Techniques

Genetic engineering techniques – use of molecular markers - recombinant DNA technology – gene transfer methods – *in-vitro* mutation for biotic and abiotic stresses – achievements, problems and future thrusts in horticultural biotechnology.

Current Stream of Thought

Practical

Tissue culture laboratory organization – aseptic manipulation – culture media preparation – inoculation of explants for clonal propagation – shoot tip, meristem – callus initiation and multiplication – sub-culturing techniques – regeneration of plants – techniques of anther and ovule culture – somaclonal variation – *in-vitro* mutation – selection for abiotic stresses – development of protocols for mass multiplication – project development for establishment of commercial tissue culture laboratory

Lecture schedule

- 1. Role of biotechnology in horticultural crops.**
- 2. Influence of plant materials and physical factors on growth and development of plant cell tissues and organs.**
- 3. Role of chemical factors on growth and development of plant cell tissues and organs.**
- 4. Callus cultures, isolation, initiation, development and multiplication.**
- 5. Meristem culture for disease elimination.**
- 6. Production of haploids and dihaploids through anther, pollen and ovule culture.**
- 7. Embryo culture techniques, wide hybridization and embryo rescue.**
- 8. Endosperm culture and its applications.**
- 9. Rapid *in vitro* clonal propagation through direct organogenesis.**
- 10. Somatic embryogenesis and regeneration of plantlets.**
- 11. Hardening and establishment of tissue cultured plantlets in the primary, secondary nursery and field.**
- 12. Somaclonal variations and its applications.**
- 13. Types of cell cultures.**
- 14. Development of suspension cultures, types of cultures and influence of different factors.**
- 15. *In vitro* production of secondary metabolites**

16. Role of bioreactors in production of secondary metabolites
17. Mid-semester examination
18. Protoplast culture and regeneration and protoplast fusion.
19. Construction of somatic hybrids and cybrids.
20. Techniques of *in vitro* pollination and fertilization.
21. *In vitro* mutation and its applications
22. Synthetic seed production techniques
23. Applications and limitations of synthetic seeds.
24. *In vitro* conservation and cryopreservation techniques.
25. Plant DNA isolation technique.
26. PCR amplification, principles, methods and applications.
27. Gel electrophoresis.
28. Genetic Engineering and transgenics.
29. Vectors and methods of transformation.
30. Indirect methods, Agrobacterium mediated gene transfer.
31. Gene transfer, microinjection, PEG and Viral mediated transfection
32. Selection of the transformed plants.
33. Transgenic plants in horticultural crops.
34. Achievements of bio-technology in horticultural crops.

Practical schedule

1. Components of tissue culture laboratory.
2. Laboratory equipments-uses and methods of operation.
3. Nutrient stock and growth regulator stock preparation.
4. Culture media preparation.
5. Sterilization techniques for glassware and media.
6. Inoculation of explants for direct organogenesis.
7. Inoculation of explants for callus culture.
8. Clonal propagation through meristem culture.
9. Anther, pollen and ovule culture.
10. Sub-culturing techniques for regeneration.
11. Induction of multiple shoots and roots.
12. *In vitro* screening of cell lines for abiotic stress.
13. *In vitro* mutation for abiotic stress.
14. Synthetic seed production.
15. Hardening techniques.
16. Visit to leading commercial tissue culture units.
17. Project preparation for establishment of tissue culture labs.

Course Outcome

The student will be able to

CO1- understand basic principles and concepts of biotechnology

CO2- understand about molecular markers and their role in breeding of horticultural crops

CO3- understand genetic engineering techniques and their achievements

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|----------|----------|----------|----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|
| CO1 | X | X | X | X | X | X | X | | | X | X | | X | |
| CO2 | X | X | X | X | X | X | X | | | X | X | | X | |
| CO3 | X | X | X | X | X | X | X | | | X | X | | X | |

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HOR 822 ADVANCES IN NUTRITION MANAGEMENT OF HORTICULTURAL CROPS (2+1)

Learning Objectives

- To update knowledge on the principles and recent research trends in nutrient management of Horticultural crops
- To impart knowledge of soil and water analysis and its impact on horticultural crop production
- To ascertain nutrient management practices for different cropping systems

Theory

Unit-I Introduction

Role of mineral nutrients, factors affecting nutrition – influence of nutrition on productivity and quality - problem soils and reclamation- root systems in perennial and annual horticultural crops – methods of root studies - laboratory method – indirect method – factors affecting root growth – effect of path system on nutrient uptake.

Unit-II Nutrient analysis

Leaf nutrient guide – factors affecting nutrient concentration in tissue - collection, handling and preparation of samples – leaf nutrient guide – critical nutrient concept - nutrient range – nutrient balance – crop logging –critical path analysis – DRIS – boundary line concept – limitations of leaf analysis.

Unit-III Sources of Nutrients

Sources of nutrients –organic and inorganic nutrients – organic, bulk and concentrated nutrients, bio-fertilizers, foliar supplements - efficient use of fertilizers – INM – time and method of placement – slow release fertilizers – fertilizer management in protected cultivation – water soluble fertilizers – fertigation methods and components.

Unit-IV Nutrient management

Effect of nutrients on growth and fruiting of horticultural crops-nutrient deficiency and toxicity and their rectification (micro and macro nutrients)- nutrient management for different cropping systems.

Unit-V Hydroponics

Water channel qualities – salt water and its impact –reclamation –hydroponics – concept – methods – aggregate – non aggregate – open and closed system – NFT and aeroponics.

Current Stream of Thought

Practical

Soil sampling methods and properties of Soil analysis – methods - soil analysis - visit to soil fertility lab -water quality analysis - plant sample analysis - interpretation of

results - hydroponics – solution - fertigation equipments for WSF -leaf nutrient guide - preparation of fertilizer solution and calculation.

Lecture schedule

1. Role of mineral nutrients
2. Factors affecting nutrition
3. Influence of nutrition on productivity and quality
4. Problem soils and reclamation
5. Root systems in perennial and annual horticultural crops
6. Methods of root studies, factors affecting root growth system
7. Effect of path system on nutrient uptake.
8. Factors affecting nutrient concentration in tissue analysis
9. Critical nutrient concept
10. Critical path analysis
11. DRIS and Boundary line concepts
12. Limitation of leaf analysis.
13. Fertilizers - classification of N,P and K fertilizers
14. Sources of nutrients
15. Organic manures- classification and sources- Fortified organics
16. Composting techniques- aerobic and anaerobic (Bangalore and Coimbatore method) enriched FYM and vermicompost.
17. Mid semester examination
18. Composting of organic waste-Sugarcane trash and coir waste
19. Integrated nutrient management and its concept
20. Slow release fertilizers
21. Preparation and characteristics and compatibility - specialty/ customized fertilizers, water soluble fertilizers, liquid fertilizers, micro nutrient mixtures and chelated micronutrients
22. Fertilizer Control Order
23. Fertilizer management under protected condition
24. Methods of fertilizer application for different soil types.
25. Fertigation - water soluble fertilizers
26. Types of fertigation - fertilizer schedule
27. Fertilizer application methods - seed coating, pelletization, seedling dipping - nutriseed pack - soil application - foliar spray
28. Nutrient management concepts in horticultural crops
29. Nutrient deficiency and toxicity and their rectification (micro and macro nutrients)
30. Nutrient management for different cropping systems.
31. Water channel qualities
32. Salt water and its impact reclamation
33. Hydroponics , concepts and methods
34. NFT and aeroponics

Practical schedule

1. Soil sampling methods and preparation of soil samples
2. Estimation of various properties of soil
3. Methods of root studies - laboratory method and indirect method of analysis
4. Leaf tissue analysis – collection, handling and preparation of samples
5. Water quality analysis
6. Plant sample analysis for major nutrients
7. Plant sample analysis for micro nutrients
8. Preparation of hydroponics solution
9. Preparation and calculation of nutrient solutions under soil less culture
10. Nutrient film technique

11. Study about the fertigation systems
12. Preparation of organic formulations
13. Nutritive analysis for estimating the potential of organics
14. Study about aeroponics system.
15. Colloquium on establishment of soil testing laboratories-soil test based fertilizer prescription
16. Visit to STL and FTL,
17. Visit to fertilizer manufacturing / mixing unit

Course Outcome

The student will be able to

CO1- explain how chemical and physical properties of soils and substrates affect nutrient availability

CO2-. Can analyse plant & samples and interpret soil, water, and tissue tests

CO3- Design fertilizer schedules for hydroponic systems and fertigation

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | X | X | X | | X | | | X | X | | X | |
| CO2 | X | X | X | X | X | | X | | | X | X | | X | |
| CO3 | X | X | X | X | X | | X | | | X | X | | X | |

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HOR 823 ADVANCES IN POST HARVEST MANAGEMENT OF HORTICULTURAL CROPS (2+1)

Learning Objectives

- To teach advances in post harvest technology and value addition of horticultural crops.
- To study about various storage techniques of horticultural crops
- To study about modern methods of processing of horticultural crops
- To study about essential oil extraction from horticultural crops

Theory

Unit-I Importance of post harvest management

Importance of post harvest management and value addition of fruits and vegetables - An over view on the post harvest losses of fresh fruits and vegetables in India- prospects for value addition and product development in fruits and vegetables- climacteric and non-climacteric fruits - respiration and ripening- ethylene metabolism, its biosynthesis and regulation-changes in enzymes and texture.

Unit-II Methods of storage

Studies on storage - importance of storage, CA and MA storage-irradiation technology-type of packages and their importance-specification and quality control in packaging-transportation of perishables and processed commodities-special techniques for transporting of horticultural perishables through sea and air routes.

Unit-III Processing and value addition in fruit crops

Latest technologies in processing and value addition of commercial fruits (Tropical, sub-tropical and temperate)-recent concepts in the processing of fruit juices, juice concentrates, fruit pulp, fermented and unfermented beverages, fruit flavours, aromatics and pigments- development of new and innovative products in fruits with emphasis on export.

Unit-IV Processing and value addition in vegetable crops

Modern methods in processing and value addition of vegetables for the domestic and export markets-innovations in dried and dehydrated vegetable products- improved recipes of pickles, sauces, ketchup, vegetable extracts and powders for global trading- vegetable flavours, essences, aromatics and pigments- research and development efforts on product diversification in vegetables.

Unit-V Post harvest management techniques in other horticultural crops and quality control standards

Post harvest management in flower and other horticultural crops- extraction of essential oils from flowers, spices, medicinal and aromatic crops. BIS, AGMARK, Codex Alimentarius -food standards FPO, PFA, etc.-Food laws and regulation- food safety- hazard analysis and critical control points (HACCP)- role of NHB, APEDA- plant quarantine and other certifying agencies governing internal and foreign trade of harvested produce-labeling and labeling act, nutrition labeling. Utilization of byproducts from processing industry- Management of waste from processing factory- investment analysis. Principles and methods of sensory evaluation of fresh and processed products.

Current Stream of Thought

Practical

Harvesting of fruits and vegetables for specific requirements-studies on pre-harvest factors and their effects on quality-effects on environmental, cultural and varietal factors on post harvest behaviour of fruits and vegetables-physico-chemical studies on fruits and vegetables prior to harvesting and during post-harvest and ripening stages. Experiments on the role of ethylene in ripening-physiological changes associated with ripening. Practical exercises on developing improved products from fruits and vegetables-extraction of essential oils from flowers, spices, medicinal and aromatic crops-visits to modern processing units and familiarization of unit operations. Visits to quarantine stations,bulk packaging units of shipping and air transporting centres of fruits and vegetable products.

Lecture schedule

- 1. Importance of post harvest management and value addition of fruits and vegetables**
- 2. Over view on the post harvest losses of fresh fruits and vegetables in India**
- 3. Prospects for value addition and product development in fruits and vegetables**
- 4. Respiration- Climacteric and non-climacteric fruits**
- 5. Ripening- ethylene metabolism, its biosynthesis and regulation**

6. Changes in enzymes and texture
7. Storage – importance of storage, CA and MA storage
8. Irradiation technology
9. Packaging- type of packages and their importance
10. Specification and quality control in packaging
11. Transportation of perishables and processed commodities
12. Special techniques for transporting of horticultural perishables through sea
13. Special techniques for transporting of horticultural perishables through air routes
14. Latest technologies in processing and value addition of commercial fruits (Tropical, sub- tropical and temperate)
15. Recent concepts in the processing of fruit juices, juice concentrates, fruit pulp,
16. Fermented and unfermented beverages
17. Mid semester examination
18. Fruit flavours, aromatics and pigments
19. Development of new and innovative products in fruits with emphasis on export.
20. Modern methods in processing and value addition of vegetables for the domestic and export markets
21. Innovations in dried and dehydrated vegetable products
22. Improved recipes of pickles, sauces, ketchup, vegetable extracts and powders for global trading
23. Vegetable flavours, essences, aromatics and pigments
24. Research and development efforts on product diversification in vegetables.
25. Post harvest management in flower crops
26. Post harvest management in spices and plantation crops
27. Post harvest management in medicinal and aromatic crops
28. Quality assurance and quality control, TQM, GMP, BIS, AGMARK, Codex Alimentarius
29. Food standards FPO, PFA, etc.
30. Food laws and regulation- food safety- hazard analysis and critical control points (HACCP).
31. Role of NHB, APEDA- plant quarantine and other certifying agencies governing internal and foreign trade of harvested produce.
32. Labeling and labeling act, nutrition labeling.
33. Utilization of byproducts from processing industry- Management of waste from processing factory- investment analysis.
34. Principles and methods of sensory evaluation of fresh and processed products.

Practical schedule

1. Exercise on harvesting of fruits based on maturity indices.
2. Pre-cooling, grading, washing and waxing treatments.
3. Collection and practicing usage of various packaging materials.
4. Experiments to hasten ripening of fruits.
5. Experiments on extension of shelf life vegetable crops.
6. Practice in judging the maturity of vegetable crops
7. Experiments on methods of preservation, changes occurring during preservation.
8. Study of machinery and equipments used in processing of horticultural produce.
9. Preparation of sauce and ketchup.
10. Preparation of brine and syrup for preservation.
11. Preparation of pickles.
12. Preparation of value added products from vegetables.
13. Chemical analysis for nutritive value of fresh and processed vegetables.
14. Sensory evaluation of fresh and processed vegetables.
15. Study of food standards. National, international standards.

16. Visit to processing units, to study the layout, equipments, hygiene, sanitation and residual / waste management.

17. Project preparation to establish processing industry.

Course Outcome

The student will be able to

CO1- Understand the post harvest technology of fruits and vegetables

CO2- Prepare project proposal for establishing a processing industry

CO3- capable of managing a processing industry

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | X | X | X | X | | | | X | X | X | X | X |
| CO2 | X | X | X | X | X | X | | | | X | X | X | X | X |
| CO3 | X | X | X | X | X | X | | | | X | X | X | X | X |

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HOR 824 ADVANCES IN PRODUCTION TECHNOLOGY OF FRUIT CROPS (2+1)

Learning Objectives

- This course is designed to provide students with an in-depth understanding of the principles and practices of fruit crops production.
- Students will learn about soil fertility management, stand establishment, environmental modification pest management, and the production practices and physiological aspects of specific fruit crops.

Theory

National and International scenario in fruit production – commercial varieties - ecophysiological requirements – recent advances in propagation – rootstock influence, planting systems, high density planting, crop modelling, root zone and canopy management, nutrient management, water management, fertigation, role of bio regulators, abiotic factors limiting fruit production, physiology of flowering, pollination, fruit set and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management – physiological disorders – causes and remedies – maturity indices, harvesting, grading, packing, and ripening techniques.

Unit-I Production technology of tropical fruit crops -I

Mango, Banana and Guava

Unit-II Production technology of tropical fruit crops -II

Citrus, Papaya and Grapes

Unit-III Production technology of tropical fruit crops -III

Sapota, Pomegranate, Ber and Aonla

Unit-IV Production technology of sub - tropical fruit crops -IV

Pineapple, Avocado, Jack fruit, Mangosteen and Fig

Unit-V Production technology of temperate and nuts crops -V

Apple, Pear, Peach, Plums, Strawberry and Nut crops

Current Stream of Thought

Practical

Description of species, cultivars and their characters – identification of important cultivars – selection of plant parts and analysis for different nutrients – observations on growth and development – flowering behavior – practices in growth regulation – malady diagnosis – analysis of quality attributes – visit to tropical, subtropical and temperate orchards, project preparation for establishing commercial orchards

Lecture schedule

- 1. Scope and current status of area- production and export of tropical and dry land fruit crops in India- scope for cultivation and area expansion- industrial and export potential.**

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

2-4. Mango.

5-7. Banana

8-9. Guava

10. Citrus introduction

11. Acid lime

12. Lemon

13. Oranges

14. Other citrus fruits

15-16. Papaya

17. Mid- semester examination

18-19. Grapes

20. Sapota

21. Pomegranate

22. Ber

23. Amla

24-25. Pine apple

26. Avocado

27..Jack

28. Mangosteen

29. Fig

30. Apple,pear
31. Peach and plum
32. Straw berry
- 33.Nut crops
34. Processing industries for tropical and arid zone fruit crops

Practical schedule

1. Identification of important cultivars, observations on growth and development in mango.
2. Practices in growth regulation and malady diagnosis in mango.
3. Identification of important cultivars, observations on growth and development in banana.
4. Special practices, growth regulation and malady diagnosis in banana
5. Identification of important cultivars, observations on growth and development in citrus.
6. Practices in growth regulation and malady diagnosis in citrus.
7. Identification of important cultivars, observations on growth and development, practices in growth regulation, papain extraction and malady diagnosis in papaya.
8. Identification of important cultivars, observations on growth and development, growth regulation, and malady diagnosis in sapota.
9. Identification of important cultivars, observations on growth and development, practices in growth regulation and malady diagnosis in guava.
10. Identification of important cultivars, observations on growth and development, practices in growth regulation and malady diagnosis in pomegranate.
11. Identification of important cultivars, observations on growth and development, practices in growth regulation and malady diagnosis in jackfruit.
12. Analysis of quality attributes in fruit crops- TSS, acidity and ascorbic acid.
13. Analysis of quality attributes in fruit crops – sugars and carotenoids.
14. Project preparation for establishing commercial orchards.
- 15-16. Visit to commercial tropical orchards.
17. Visit to arid zone orchards.

Course Outcome

The student will be able to

CO1- Demonstrate proficiency in the cultural practices and management of sustainable fruit production.

CO2-. Able to recommend suitable post harvest techniques for fruit crops

CO3- Will be able to manage commercial fruit production units

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | X | X | X | | X | | | X | X | | | |
| CO2 | X | | | X | X | | X | | | X | X | | | |
| CO3 | X | X | | | X | | X | | | X | X | | | |

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HOR 825 : ADVANCES IN PRODUCTION TECHNOLOGY OF VEGETABLE CROPS (2+1)
Learning Objectives

- This course is designed to provide students with an in-depth understanding of the principles and practices of sustainable vegetable crops production and physiology.
- Students will learn about soil fertility management, stand establishment, environmental modification pest management, greenhouse production, and the production practices and physiological aspects of specific vegetable crops.

Theory

Horticultural classification – area and production – export potential – present status and prospects of vegetable cultivation – nutritional and medicinal values – climate and soil – varieties and hybrids – nursery management – seeds and sowing – seed treatment – seed and seedling hardening – container production of vegetable seedlings – modern concepts in water and weed management – physiological basis of growth, yield and quality as influenced by chemicals and growth regulators – role of PGR'S in breaking dormancy, induction of flowering, sex expression, fruit set , yield and quality – vegetable forcing as a specialized industry – role of organic manures, inorganic fertilizers to low and high nutrient management – nutritional deficiencies – disorders and correction methods – different cropping systems – use of mulches – soil solarization – principles and application – rotation, succession, companion and intercropping – edible maturity standards – harvesting and grading – seed production techniques – post harvest handling, storage – marketing of vegetables – vegetable production for pigments, processing of vegetables.

Unit-I Production technology of solanaeous vegetables

Tomato, brinjal, chillies and potato

Unit-II Production technology of malvaceous and cucurbitaceous vegetables

Bhendi, pumpkin, ash gourd, bottle gourd, bitter gourd, snakegourd, muskmelon, water melon and cucumber

Unit-III Production technology of leguminous vegetables

Cluster bean, dolichos bean, vegetable cowpea, vegetable soyabean, amaranthus and drumstick

Unit-IV Production technology of cruciferous vegetables and root crops

Cabbage, cauliflower, brussel sprouts, sprouting broccoli, knol-khol, turnip, beetroot, carrot and radish

Unit-V Production technology of bulb and tuber crops

Onion, sweet potato, tapioca, yam and taro

Current Stream of Thought

Practical

Identification and description of varieties and hybrids of vegetables – seed treatment – nursery practice – flowering behaviour and pollination problems – Identification of macro and micro nutrient deficiencies, physiological disorders and methods of correction – analysis of physiological factors like photosynthesis, light intensity in different cropping situation – application of growth regulators to enhance seed germination, fruitset, yield and quality – practices in herbicide application, estimating water requirements in relation to crop growth stages, maturity indices – dryland techniques for rainfed vegetable production – vegetable waste recycling management – analysis for quality and nutrient compostion – storage studies – cost benefit analysis – marketing survey of the above crops

– project preparation for commercial vegetable cultivation – visit to vegetable markets and packing houses.

Lecture schedule

- 1. Introduction, classification, scope and importance of vegetable crops.**
- 2-3. Tomato**
- 4-5. Brinjal**
- 6-7. Chillies**
- 8. Sweet pepper**
- 9-10. Potato**
- 11. Okra**
- 12. Pumpkin**
- 13. Ash gourd**
- 14. Bottle gourd and bittergourd**
- 15. Snake gourd**
- 16. Cucumber**
- 17. Mid-semester examination**
- 18. Cluster bean**
- 19. Dolichos bean**
- 20. Vegetable cowpea and Soya bean**
- 21. Amaranthus**
- 22. Moringa**
- 23. Cabbage**
- 24. Cauliflower**
- 25. Branel sp**
- 26. Knol-khol and brings**
- 27. Beetroot and brng**
- 28. Carrot**
- 29-30 ulbous vegetables**
- 31. Elephant foot yam**
- 32. Tapioca**
- 33. Elephant foot yam**
- 34. Taro**

Practical schedule

- 1. Description of commercial varieties / hybrids in solanaceous vegetables.**
- 2. Description of commercial varieties / hybrids in cucurbits.**
- 3. Description of commercial varieties / hybrids in okra, onion and moringa.**
- 4. Description of commercial varieties / hybrids in tapioca and sweet potato.**
- 5. Seed treatment and nursery practices in summer vegetables.**
- 6. Fertigation practices in vegetables.**
- 7. Assessing the efficiency of plant growth regulators in warm season vegetables.**
- 8. Identification of biotic stresses in warm season vegetables.**
- 9. Assessing the maturity standards and harvest indices in solanaceous vegetables and okra.**
- 10. Assessing the maturity standards and harvest indices in cucurbits, onion and dolichos bean.**
- 11. Seed production techniques in solanaceous vegetables.**
- 12. Seed production techniques in cucurbits.**
- 13. Seed production techniques in okra and onion**
- 14. Preparation of cropping scheme for commercial farms.**
- 15. Visit to vegetable markets.**
- 16. Working out cost economics for commercial cultivation of warm season Vegetables**

17. Protected cultivation of tropical vegetables.

Course Outcome

The student will be able to

CO1- Demonstrate proficiency in the cultural practices and management of sustainable vegetable crops production.

CO2- Able to recommend suitable post harvest techniques for vegetable crops.

CO3- Will be able to manage commercial vegetable production units.

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | X | X | X | | X | | | X | X | | | |
| CO2 | X | X | | | X | | X | | | X | X | | | |
| CO3 | X | X | X | | X | | X | | | X | X | | | |

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HOR 827 ADVANCES IN PRODUCTION TECHNOLOGY OF FLOWER CROPS (2+1)

Learning Objectives

- This course is designed to provide students with an in-depth understanding of the principles and practices of sustainable flower crops production and physiology.
- Students will learn about soil fertility management, stand establishment, environmental modification pest management, greenhouse production, and the production practices and physiological aspects of specific flower crops.

Theory

Unit-I Scope and importance of flower crops

Scope and importance of commercial flower production- global scenario in cut flower production and trade- varietal wealth and diversity- special characters and requirements for cut flowers, loose flowers, dry flowers and floral oil trade- flower production problems in India

Unit-II Propagation techniques of flower crops

Propagation and multiplication, nursery management- media for nursery- special nursery practices- IPR issues related to propagation materials- growing environment- open cultivation, protected cultivation- soil requirement- artificial growing media- soil and media decontamination.

Unit-III Protected cultivation of flower crops

Greenhouse management- planting methods- systems of planting- influence of environmental parameters- light, temperature, moisture, humidity and CO₂ on growth and flowering- regulation for quality flowers- water and nutrient management- microirrigation

and fertigation- slow release fertilizers, bio fertilizers and water soluble fertilizers- flower forcing, special horticultural practices- physiological disorders- IPM- IDM

Unit-IV Production technology of loose flowers

Crop specific practices of loose flower production- jasmine, scented rose, chrysanthemum, tuberose, marigold, crossandra, nerium, gomphrena and non-traditional flowers

Unit-V Production technology of cut flowers

Crop specific practices of cut flower production- cut rose, cut chrysanthemum, carnation, gerbera, gladiolus, cut tuberose, orchids, anthurium, aster, lillium, bird of paradise, limonium and cut foliage

Current Stream of Thought

Practical

Botanical description of species and varieties- propagation techniques, mist chamber operation- soil decontamination techniques- practices in manuring, drip irrigation and fertigation- foliar nutrition, growth regulator application- special practices- pinching, netting, disbudding, staking, defoliation, training and pruning techniques- photoperiodic and chemical regulation of flowering- crop specific practices for commercial flowers- assessing harvest indices- post harvest handling- case studies and project preparation for regionally important cut flowers- visit to commercial cut flower units.

Lecture schedule

1. Scope and importance of commercial flower production
2. Global scenario in cut flower production and trade
3. Varietal wealth and diversity of commercial flowers
4. Special characters and requirements for cut flowers
5. Special characters and requirements for loose flowers
6. Special characters and requirements for dry flowers
7. Special characters and requirements for floral oil trade
8. Flower production problems in India
9. Propagation and multiplication of commercial flowers
10. Nursery management for commercial flowers
11. Media for nursery
12. Special nursery practices for commercial flowers
13. IPR issues related to propagation materials
14. Systems of planting
15. Growing environment- open cultivation, protected cultivation
16. Soil requirement- artificial growing media
17. Mid-semester examination
18. Soil and media decontamination techniques
19. Greenhouse management
20. Planting methods
21. Influence of environmental parameters- light, temperature, moisture, humidity and CO₂ on growth and flowering
22. Regulation for quality flowers
23. Water and nutrient management for commercial flowers
24. Microirrigation and fertigation- slow release fertilizers, bio fertilizers and water soluble fertilizers-
25. Flower forcing, special horticultural practices
26. Physiological disorders- IPM- IDM
27. Crop specific practices of loose flower production- jasmine, scented rose,
28. Chrysanthemum, tuberose
29. Marigold, crossandra, nerium, gomphrena
30. Non-traditional flowers

31. Crop specific practices of cut flower production- cut rose, cut chrysanthemum
32. Carnation, gerbera, anthurium,
33. Gladiolus, cut tuberose, orchids
34. Aster, Lilium, bird of paradise, limonium and cut foliages

Practical schedule

1. Botanical description of species and varieties of commercial flowers
2. Propagation techniques of commercial flowers
3. Mist chamber operation
4. Soil decontamination techniques
5. Practices in manuring
6. Practices in drip irrigation and fertigation
7. Practices in foliar nutrition
8. Practices in growth regulator application
9. Special practices- pinching, netting, disbudding, staking, defoliation
10. Training and pruning techniques
11. Photoperiodic and chemical regulation of flowering
12. Assessing harvest indices
13. Post harvest handling
14. Crop specific practices for loose and non traditional flowers
15. Crop specific practices for cut flowers
16. Case studies and project preparation for regionally important cut flowers
17. Visit to commercial cut flower units

Course Outcome

The student will be able to

CO1- Will gain understanding on the principles and practices of sustainable flower crops production and physiology.

CO2-. Will understand production problems and scientific basis of problems solving in commercial flower production.

CO3- Will gain practical exposure in cut and loose flower production and post harvest process.

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | X | X | X | | X | | | X | X | | | |
| CO2 | X | X | X | X | X | | X | | | X | X | | | |
| CO3 | X | X | | | X | | X | | | X | X | | | |

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HOR 828 ADVANCES IN CROP IMPROVEMENT AND PRODUCTION TECHNOLOGY OF MEDICINAL AND AROMATIC CROPS (2+1)

Learning Objectives

- This course is designed to provide students with an in-depth understanding of the principles and practices of sustainable medicinal and aromatic crops production and physiology.
- Students will learn about soil fertility management, stand establishment, environmental modification pest management, greenhouse production, and the production practices and physiological aspects of specific medicinal and aromatic crops.

Theory

Unit-I Introduction

Genetic bio-diversity of medicinal plants – conservation networks –global initiatives on medicinal plants – export and import status – advanced research in bio-medicines, Nutraceuticals and natural drugs – role of institutions and NGO's in production – IPR in medicinal and crops.

Unit-II Scope and objectives of breeding of medicinal and aromatic crops

Major objectives of breeding of medicinal and aromatic crops- scope for introduction: Scope for improvement of medicinal and aromatic crops through various breeding methods breeding for yield and quality improvement achievements and prospects a bio-technological approaches.

Unit-III Production technology of medicinal crops -I

Production technologies with reference to crop improvement, climate, soil and substrate culture – improved varieties – organic production – nutrition and irrigation requirements - interculture – mulching – weed control – maturity indices – harvesting and economics of cultivation of the following crops: Senna, Periwinkle, Coleus, Ashwagandha, Glory lily, Dioscorea sp., *Aloe vera*.

Unit-IV Production technology of medicinal crops -II

Production technologies with reference to crop improvement, climate, soil and substrate culture – improved varieties – organic production – nutrition and irrigation requirements - inter-culture – mulching – weed control – maturity indices – harvesting and economics of cultivation of the following crops: sarpagandha, medicinal solanum, Isabgol, Safed Musli, Stevia, Gymnema.

Unit-V Production technology of aromatic crops

Aromatic industry – export and import status – advances in production technology for Palmarosa, Lemongrass, Citronella, Vettiver, Geranium, Mentha, Ocimum, Eucalyptus, Rosemary, Thyme, Patchouli, Lavender, Marjoram, Organism.

Current Stream of Thought

Practical

Botanical description – propagation techniques – seed treatment - maturity standards - project preparation for commercial important medicinal plants – visit to medicinal crop field and herbal extraction units – extraction of essential oils – project preparation for commercially important aromatic plants – visit to distillation and value addition units.

Lecture schedule

1. Biodiversity and germplasm conservation
2. Herbal industry, WTO scenario, export and import status.
3. Indian system of medicine, indigenous traditional knowledge of medicinal plants.
4. Methods of breeding for medicinal plants
5. Methods of breeding for aromatic plants
6. Biotechnological approaches in breeding of medicinal plants and aromatic plants
7. IPR issues and PPFR
8. Classification of medicinal plants and systems of cultivation.

Climate and soil requirements, varieties-site selection, season and method of propagation, pre sowing treatment, irrigation and nutrient management, intercultural operations, plant protection measures, maturity indices-harvesting and post harvest management of the following crops:

9. Senna
 10. Coleus
 11. Ashwagandha
 12. Glory lily
 13. Sarpagandha
 14. Dioscorea and Aloe vera
 15. Phyllanthus and kalmegh
 16. Gymnema
 17. Mid -semester examination
 18. Medicinal solanum and ipecac
 19. Isabgol and safedmusli
 20. Poppy
 21. Periwinkle and stevia
 22. Phytochemical extraction techniques
 23. Aromatic industry- WTO scenario- export and import status
 24. Indian perfumery industry- history-advancements in perfume industry
 25. Palmarosa and lemongrass
 26. Citronella and vetiver
 27. Geranium and artemisia
 28. Mint
 29. Ocimum
 25. Patchouli
 26. Rosemary and thyme
 27. Origanum and marjoram
 28. Lavender and eucalyptus
 29. Organic production of medicinal and aromatic crops
 30. IPR issues for medicinal and aromatic crops
 31. Role of institutions and NGO's in production and regulations for herbal raw materials
 32. Distillation methods, advanced methods-solvent extraction process, steam distillation
 33. Perfumes from non-traditional plants.
 34. Quality analysis, value addition, aroma chemicals, quality standards and regulation.
- .Practical schedule
1. Study of floral biology, anthesis and pollination mechanisms in medicinal crops.
 2. Study of floral biology, anthesis and pollination mechanisms in aromatic crops.
 3. Characterization, evaluation and screening of germplasm accessions in medicinal crops.
 4. Characterization, evaluation and screening of germplasm accessions in aromatic crops.
 5. Breeding techniques in medicinal crops.
 6. Breeding techniques in aromatic crops. Practices in in-vitro approaches in improvement of medicinal crops.
 7. Practices in in-vitro approaches in improvement of aromatic crops.
 8. Identification and description of high alkaloid and essential oils.
 9. Visit to radiation laboratory.
 10. Description of species - improved cultivars - propagation techniques - maturity standards - harvest and post harvest handling of medicinal crops
 11. Description of species - improved cultivars - propagation techniques - maturity standards - harvest and post harvest handling of aromatic crops

12. Extraction of secondary metabolites in medicinal crops
13. Extraction of essential oils from aromatic crops
14. Project preparation for commercially important medicinal and aromatic crops
15. Field visit to commercial medicinal plantations
16. Field visit to commercial aromatic plantations
17. Visit to herbal extraction units, distillation and value addition units

Course Outcome

The student will be able to

CO1- Demonstrate proficiency in the cultural practices and management of sustainable medicinal and aromatic crop production

CO2-Recommend suitable post harvest techniques for medicinal and aromatic crops

CO3- Manage commercial value addition units

CO - PSO - PO Mapping

| | PS O1 | PS O2 | PS O3 | PS O4 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-----|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|-------|
| CO1 | X | X | | X | X | | X | | | X | X | | | |
| CO2 | X | | X | | X | | X | | | X | X | | | |
| CO3 | | | | X | X | | X | | | X | X | | | |

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