

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

- c) 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 candidates 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-incidence 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 avaluation.

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 Bibilography, 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 PLANT PATHOLOGY

GPAT 81 Ph.D. in Agriculture (Plant Pathology)

Programme Outcomes for PhD

- PO 1** In-depth knowledge of literature in the specialised area of research
- PO 2** Apply theories, methodologies and techniques to address fundamental research problems
- PO 3** Creativity and originality in planning and executing research independently
- PO 4** Critical thinking, problem solving and evaluation of published work
- PO 5** Ability to formulate and test novel hypotheses
- PO 6** Develop practical research skills and expertise in state-of-the art techniques in research
- PO 7** Effective scientific writing and oral presentation skills
- PO 8** Collegiality in a research setting with people from diverse backgrounds as leaders/mentors/team members
- PO 9** Ethical principles in conducting and reporting research
- PO 10** Life-long commitment to expanding the frontiers of knowledge in a specialised field

Ph.D. Plant Pathology

Programme Specific Outcomes

A Doctorate degree in Plant Pathology prepares the students,

- PSO 1** For a career with advanced research capabilities and effective teaching skills
- PSO 2** With clear knowledge on molecular plant microbe interactions and plant innate immunity
- PSO 3** With awareness on the relationship of diseases with environment and designing management strategies
- PSO 4** With in-depth knowledge on Molecular detection and diagnosis of Biotic and Mesobiotic pathogens
- PSO 5** With understanding on Epidemiological forecasting and simulation models
- PSO 6** To become a successful entrepreneur in Mushroom cultivation, mass multiplication of bio control agents, low cost organic products for plant disease management, compost preparation etc.,

DEPARTMENT OF PLANT PATHOLOGY
GPAT 81 Ph.D BY COURSE WORK IN PLANT PATHOLOGY
(FULL TIME / PART TIME / EXTERNAL) (2019-2020)
SCHEME OF EXAMINATION

Sl. No.	Course No.	Course Title	Credit Hours
MAJOR COURSES			
1.	PAT 811	Molecular Basis of Host-Pathogen Interaction	2 + 1
2.	PAT 812	Advances in Mycology	2 + 1
3.	PAT 813	Disease Resistance, Epidemiology and Forecasting of Plant Diseases	2 + 1
4.	PAT 814	Integrated Disease Management	2 + 1
5.	PAT 821	Advances in Virology	2 + 1
6.	PAT 822	Advances in Bacteriology	2 + 1
7.	PAT 823	Post Harvest Pathology and mushroom production	2 + 1
8.	PAT 824	Advances in Biological Control of Plant Diseases	2 + 1
MINOR COURSES			
1.	PAT 815	Biological control of soil borne pathogen	2+1
2.		Other Department Course	2+1
3.		MOCC / SWYAM	2 + 0
SUPPORTING COURSES			
1.	COM 811	Advances in computer application	0 + 1
2.	LIB 812	Library	0 + 1
3.	STA 821	Advances in Design Experiments	2 + 1
4.	PAT 081	Seminar	0 + 1
5.	PAT 082	Seminar	0 + 1
6.	PAT 80*	Research	0 + 45
		Total	16 + 59 = 75

GPAT 81 Semester wise distribution
Department of Plant Pathology (Revised Syllabus 2019-2020 onwards)

Course No.	Course Title	Credit Hours
Semester - I		
Major Courses		
PAT 811	Molecular Basis of Host-Pathogen Interaction	2 + 1
PAT 812	Advances in Mycology	2 + 1
PAT 813	Disease Resistance, Epidemiology and Forecasting of Plant Diseases	2 + 1
PAT 814	Integrated Disease Management	2 + 1
Minor Courses		
PAT 815	Biological control of soil borne pathogens	2+1
Supporting Courses		
COM 811**	Advances in computer application	0 + 1
LIB 812**	Library	0 + 1
PAT 801	Research	0 + 1
PAT 081	Seminar	0 + 1
TOTAL		16 Credits
Semester - II		
Major Courses		
PAT 821	Advances in Virology	2 + 1
PAT 822	Advances in Bacteriology	2 + 1
PAT 823	Post Harvest Pathology and mushroom production	2 + 1
PAT 824	Advances in Biological Control of Plant Diseases	2 + 1
Minor Courses		
	Other Department Course	2 + 1
	MOCC / SWYAM	2 + 0
Supporting Courses		
STA 821**	Advances in Design Experiments	2 + 1
PAT 802	Research	0 + 2
PAT 082	Seminar	0 + 1
TOTAL		17 Credits
Semester - III		
PAT 803	Research	0 + 12
Semester - IV		
PAT 804	Research	0 + 12
Semester - V		
PAT 805	Research	0 + 12
Semester - IV		
PAT 806	Research	0 + 6
TOTAL RESEARCH CREDITS		45 Credits
TOTAL FOR SIX SEMESTER		75 Credits

* Compulsory course

Choose 3 out of 4 and 2 out of 4 major courses in I & II semester respectively

All minor courses should be from other Departments or disciplines

PAT 811 MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION (2 + 1)

Learning Objectives

- To study the concepts of biotechnological tools in Plant Pathology
- To study the host pathogen interaction and signal transduction
- To study the Pathogenesis related proteins and Systemic acquired resistance
- To study the genetics of the pathogen.
- To study the Biotechnological approaches for plant disease management

Theory

Unit I Introduction

Importance and role of biotechnological tools in Plant Pathology- Basic concepts and principles to study of host pathogen relationship.

Unit II Host pathogen interaction

Molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system, signal transduction.

Unit III Pathogenesis related proteins

Induction of defense responses- Pathogenesis Related proteins, HR, reactive oxygen species, phytoalexins and systemic acquired resistance, Programmed cell death, Viral induced gene silencing.

Unit IV Genetics of pathogen

Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes.

Unit V Biotechnology for Disease Management

Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

Practical

Protein, DNA and RNA isolation, Plasmids extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation.

Theory Schedule

1. Importance of biotechnological tools in plant pathology
2. Role of biotechnological tools in plant pathology
3. Basic concepts of plant pathogen relationship
4. Principles of plant pathogen relationship
5. Molecular plant pathology – Introduction
6. Molecular basis of plant and fungal pathogen interaction
7. Molecular basis of plant and bacterial pathogen interaction
8. Molecular basis of plant and viral pathogen interaction
9. Pathogen recognition system
10. Disease resistance – terminologies
11. Systemic acquired resistance
12. Induced systemic resistance
13. Plant pathogenesis
14. Variability of Plant Pathogens
15. Process of pathogen infection
16. Physiological races of pathogen
17. **Mid-semester examinations**
18. Host defense – system
19. Induction of defense response

20. Pathogenesis related proteins – 1
21. Pathogenesis related proteins – 2
22. Morphological resistance
23. Anatomical resistance
24. Hypersensitive response
25. Reactive oxygen Species
26. Phytoalexins
27. Programmed cell death
28. Viral induced gene silencing
29. Gene for gene hypothesis
30. R gene expression, transcription profiling
31. Cloning of resistance genes
32. Pyramiding of R genes
33. Bio technology – Genetic engineering – gene transfer
34. Bio safety issues

Practical Schedule

1. Isolation of protein
2. RNA isolation
3. DNA isolation
4. Plasmids extraction
5. PCR analysis
6. RT-PCR
7. Electrophoresis
8. DNA and protein electrophoresis
9. β -1,3 glucanase study
10. Assay of PAL
11. Analysis of phytoalexin
12. Assay of chitinase
13. Isolation of elicitors
14. Plant tissue culture – genetic engineering
15. Plant tissue culture – genetic engineering
16. Bacterial transformation
17. Record Certification

Course Outcome

- CO 1** Having in depth knowledge in the biotechnological tools used in plant pathology
- CO 2** Knowing the molecular plant pathogen interaction
- CO 3** Being updated with defense responses in plants - PR proteins and their function
- CO 4** Knowing the Gene for gene hypothesis
- CO 5** Practical knowledge in biotechnological approaches for plant disease resistance

CO – PSO – PO Mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1		x		x				x								
CO 2		x		x			x									
CO 3		x		x			x				x	x				
CO 4		x		x								x				
CO 5		x		x					x			x	x	x	x	x

References

1. Chet I. 1993. Biotechnology in Plant Disease Control. John Wiley & Sons, New York.
2. Gurr SJ, Mc Pohersen MJ & Bowlos DJ. (Eds.). 1992. Molecular Plant Pathology - A Practical Approach. Vols. I & II, Oxford Univ. Press, Oxford.
3. Mathew JD. 2003. Molecular Plant Pathology. Bios Scientific Publ., UK.
4. Punja, Z.K., De Boer, S.H., Sanfacon, H. Biotechnology and Plant disease management. CABI publishing
5. Ronald PC. 2007. Plant-Pathogen Interactions: Methods in MolecularBiology. Humana Press, New Jersey.
6. Stacey G & Keen TN. (Eds.). 1996. Plant Microbe Interactions. Vols, I-III. Chapman & Hall, New York; Vol. IV. APS Press, St. Paul, Minnesota.
7. Vidhasekaran, P. 1997. Fungal Pathogens in Plants and Crops: Molecular Biology and Host Defense Mechanisms. Marcel Dekker, New York.
8. Vidhyasekaran P. 2002. Bacterial Disease Resistance in Plants: Molecular Biology and Biotechnological Applications. Food Products Press, An Imprint of Haworth Press, Inc., Binghampton, New York USA.

PAT 812 ADVANCES IN MYCOLOGY (2 + 1)

Learning Objectives

- To study the historical development and advances in mycology
- To study the recent taxonomic classification of fungi
- To study the morphology and conidiogenesis of fungi
- To study the population biology and variability of plant pathogens
- To study the sexual hormones in fungi

Theory

Unit I Introduction and History of Fungi

General introduction, historical development and advances in mycology.

Unit II Taxonomy of Fungi

Recent taxonomic criteria, morphological criteria for classification. serological, chemical (chemotaxonomy), molecular and numerical (Computer based assessment) taxonomy.

Unit III Morphology of Fungi

Interaction between groups: Phylogeny. Micro conidiation, conidiogenesis and sporulating structures of fungi. Morphological characters of fungi. Reproduction in different groups of fungi.

Unit IV Biology of Fungi

Population biology, pathogenic variability/vegetative compatibility.

Unit V Life cycle and mechanism of Fungi

Heterokaryosis and parasexual cycle. Life cycle pattern in fungi. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance.

Practical

Study of conidiogenesis- phialides, porospores, arthospores. Study of fruit bodies in Ascomycota. Identification of fungi up to species level. Study of hyphal anastomosis. Morphology of plant pathogenic genera from different groups of fungi.

Theory schedule

1. Definition, general introduction in mycology
2. Historical development in global level of mycology
3. Historical development in India
4. Importance of mycology in agriculture, relation of fungi to human affairs,
5. Binomial and trinomial systems of classification
6. Phytogeny of fungi
7. Morphological classification
8. Serological classification
9. Chemotaxonomy
10. Molecular taxonomy
11. Numerical taxonomy
12. International code of nomenclature for algae, fungi and plants
13. Nomenclature of fungi
14. Different types of classification of fungi made by different authors
15. General characters of fungi
16. Morphology of fungi

- ### Practical Schedule

- ### Course Outcome

CO 2 Being updated with the recent binomial and trinomial classification of plant pathogenic fungi

CO 4 Knowing the pathogenic variability

CO – PSO – PO Mapping

[illegible]

References

1. Alexopoulos, C.J, Mims, C.W and Blackwell M. 2010. Introductory Mycology. Wiley Publication.
2. Aneja, K.R. and Mehrotra, R.S. 2015. An Introduction to Mycology. New Age International Publishers.
3. Dube, H.C. 2012. An Introduction to Fungi, 4th edition. Scientific Publishers.
4. Ingold, C.T. and Hudson, H.J. 2013. The Biology of Fungi, 6th Edition. Scientific Publishers.
5. Kirk, P. M *et al.* 2008. Dictionary of the Fungi, 10th edition, CABI Publication.
6. Satish Kumar 2016. The Fungi. Pragati Prakashan.
7. Satyanarayana, T., Deshmukh, S.K. and Johri, B.N. 2018. Developments in Fungal Biology and Applied Mycology. Springer Publications.
8. Sethi, I.K. and Walia, S.K. 2018. Textbook of Fungi and Their Allies. Scientific International Pvt. Ltd.
9. Vashishta B.R. and Sinha A.K. 2016. Botany for Degree Students-Fungi. S. Chand & Company Ltd.
10. Webster, J. and Weber, R.W.S. 2007. Introduction to Fungi, 3rd edition. Cambridge University Press.

e-References

1. Webster, J. and Weber, R.W.S. 2007. An Introduction to Fungi.
2. San-Blas, G. and Calderone, R.A. 2004. Pathogenic Fungi: Structural Biology and Taxonomy.
3. <http://www.ima-mycology.org/>
4. www.indexfungaroum.org
5. www.mycobank.org
6. <http://www.atcc.org/>
7. <http://www.apsnet.org/Pages/default.aspx>

PAT 813 DISEASE RESISTANCES, EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES (2+1)

Learning Objectives

- To study the disease resistance and physiological races of plant pathogen
- To study the plant defense mechanism
- To study the plant disease epidemiology
- To study the Aerobiology in plant pathogenesis
- To study the plant disease forecasting methods

Theory

Unit I Introduction

Historical developments on disease resistance – Dynamics of pathogenicity: penetration, infection, regulation of infection processes–disease escape, disease tolerance – resistance biology– types of resistance–non-host resistance, horizontal resistance and vertical resistance– variability in plant pathogens, mechanisms of variability – physiological races of pathogens.

Unit II Defence mechanisms and Resistance in plants

Host defence mechanisms –Morphological and anatomical resistance – Phytoanticipins –Induced structural and biochemical defences–Phytoalexins, defense-related proteins, Hypersensitivity and its mechanisms –Induced resistance–systemic acquired resistance (SAR) and induced systemic resistance (ISR) –Genetics of disease resistance – Gene-for-gene hypothesis –Avirulence(avr) genes – Protein for protein – Resistance (R) genes of plants.

Unit III Signal transduction in plants and introduction to epidemiology

Recognition of pathogens by plants – Elicitors –Host plant receptors –Signal transduction –Signal cross talk. Epidemic concept of disease and historical developments in epidemiology–Impact of epidemics –Disease triangle –Pathometry and crop growth stages –Analysis of epidemics: monocyclic, polycyclic and polyetic diseases.

Unit IV Aerobiology and disease assessment

Weather: Effect of temperature, light, humidity, moisture, rain and drought – Microclimate and Macroclimate–Host: Boom and Burst population growth cycle–Area under disease progress curve (AUDPC) –Different disease progress model and correction factors –Inoculum dynamics –Population biology of pathogens –Temporal spatial variability in plant pathogens – Mathematical models in epidemiology.

Unit V Disease forecasting

Principles and pre-requisites of forecasting, systems (positive and negative) –Early forecasting procedures based on weather and inoculum potential –Disease prediction– Infection models –Factors affecting various components of forecasting –Disease progress models –Yield loss models and computerized disease forecasting systems–Remote sensing.

Practical

Introduction to disease resistance in plants-methods of resistance breeding– Different types of spore traps and collection of spores – Measurement of diseases– Disease intensity – Disease assessment – Recording disease intensity at different crop stages– foliar and root disease – Growth curve analysis of Plant diseases – Spatial analysis of plant diseases – Model preparation and validation – Computerized disease forecasting systems– remote sensing – Record certification.

Theory schedule

1. Introduction and historical development on disease resistance.
2. Dynamics of pathogenicity: penetration, infection, regulation of infection processes.
3. Basic terms in resistance biology: pathogen virulence, aggressiveness, susceptibility, disease tolerance, disease resistance, local resistance, systemic resistance.
4. Disease escapes, non-host resistance.
5. Types of resistance: horizontal resistance and vertical resistance.
6. Variability in plant pathogens, mechanisms of variability, physiological races of pathogens.
7. Host defense mechanisms, morphological and anatomical resistance.
8. Phytoanticipins and induced structural and biochemical defences.
9. Cork layers, abscission layer, tyloses, gums– cell wall modifications: papilla-callose, HRGP, lignifications, suberization.
10. Phytoalexins and defense-related proteins.
11. Hypersensitivity and its mechanisms.
12. Induced resistance: systemic acquired resistance, induced systemic resistance.
13. Genetics of disease resistance, Gene-for-gene theory, avirulence (avr) genes, characteristics of avr gene-coded proteins, hrp genes.
14. Protein-for-protein, resistance (R) genes of plants, management of resistance genes.
15. Recognition of pathogens by plants.
16. Elicitors-general and race-specific elicitors, endogenous and exogenous elicitors.
17. **Mid-term examination**
18. Host plant receptors, signal transduction and signal cross-talk.
19. Plant disease epidemics – introduction, epidemic concept and historical development of epidemiology.
20. Disease triangle, pyramid: Host, environment and pathogen.
21. Pathometry and crop growth stages.
22. Analysis of epidemics - monocyclic, polycyclic and polyetic diseases.
23. Weather: effect of temperature, light, humidity, moisture, rain and drought, microclimate and macroclimate.
24. Host: Boom and Burst cycle.
25. Area under disease progress curve (AUDPC).
26. Different disease progress model and correction factors.
27. Inoculum dynamics, population biology of pathogens.
28. Temporal spatial variability in plant pathogens.
29. Mathematical models in epidemiology.
30. Principles and pre-requisites of forecasting.
31. Forecasting systems (positive and negative), early forecasting procedures based on weather and inoculum potential.
32. Disease prediction- infection models, factors affecting various components of forecasting.
33. Disease progress models, yield loss models and computerized disease forecasting systems.
34. Remote sensing.

Practical Schedule

1. Introduction of disease resistance in plants.
2. Mechanism of disease resistance.
3. Methods of resistance breeding, Back cross method.
4. Development of multiline.
5. Tissue culture techniques.
6. Different types of spore traps and collection of spores.
7. Measuring disease intensity.
8. Disease assessment.
9. Field visit.
10. Recording disease intensity at different crop stages: foliar and root disease.
11. Growth curve analysis of plant disease.
12. Growth curve analysis of plant disease.
13. Model preparation and validation.
14. Model preparation and validation.
15. Computerized disease forecasting systems.
16. Remote sensing
17. Record Certification.

Course Outcome

CO 1 Knowing the disease escape, disease endurance and types of disease resistance

CO 2 Having in depth knowledge of Phytoalexins, PR Proteins and SAR, ISR Mechanism

CO 3 Knowing the Phytopathometry concepts

CO 4 Knowing the Temporal spatial variability in plant pathogens

CO 5 Trained in plant disease forecasting models and decision supporting systems

CO – PSO – PO Mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	x	x	x				x	x	x							
CO 2		x		x			x	x	x			x				
CO 3		x		x			x	x			x					
CO 4		x		x								x				
CO 5		x			x							x				

References

1. Campbell, C.L. and Madden L.V. 1990. Introduction to Plant Disease Epidemiology. John Wiley & Sons.
2. Cooke, B.M., Jones, D.G. and Kaye, B. 2006. The Epidemiology of Plant Diseases. Springer Publications.
3. Datta, S.K. and Muthukrishnan, S. 1999. Pathogenesis-Related Proteins in Plants. CRC Press.
4. Gurr, S.J., Mc Pherson, M.J. and Bowles, D.J. 1992. Molecular Plant Pathology: A Practical Approach Vol. II. IRL Press.
5. Kapoor, B. 2012. Plant Disease Epidemiology and Management. Narendra Publishing House.

6. Kranz, J. and Rotem, J. 2012. Experimental Techniques in Plant Disease Epidemiology. Springer Publications.
7. Nagarajan, S. 1983. Plant Disease Epidemiology. Oxford and IBH Publishing Company.
8. Punja, Z.K. (2004). Fungal Disease Resistance in Plants - Biochemistry, Molecular Biology and Genetic Engineering. Haworth Press.
9. Stevenson, K.L. and Jeger, M.J. 2014. Exercises in Plant Disease Epidemiology. APS Press.
10. Vidhyasekaran, P. 1988. Physiology of Disease Resistance in Plants. CRC Press.

e-References

1. <https://www.apsnet.org/edcenter/advanced/topics/EpidemiologyTemporal/Pages/default.aspx>
2. https://www.slu.se/en/departments/forest-mycologyplantpathology/research_plant_pathology/
3. <http://eagri.org/eagri50/PATH171/lec19.pdf>
4. plantpath.ifas.ufl.edu
5. <http://agrilife.org/amarillo/files/2010/10/Application-of-Spatial-Statistics-Workneh.pdf>

PAT 814 INTEGRATED DISEASE MANAGEMENT (2 + 1)

Learning Objectives

- To study the concept and tools of plant disease management
- To study the biological, chemical and cultural approaches for plant disease management
- To study the Integrated disease management practices in cereals and Pulses
- To study the Integrated disease management practices in Oilseed and cash crops
- To study the Integrated disease management practices in fruits and vegetables

Theory

Unit I Introduction

Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications.

Unit II Basic principles and disease management

Development of IDM- basic principles, biological, chemical and cultural disease management.

Unit III IDM of cereals and pulses

IDM in important crops- rice, wheat, pearl millet, sorghum and maize - Bengal gram, Red gram, black and green gram.

Unit IV IDM of Oilseeds and cash crops

IDM in important crops- groundnut, sesame, sunflower, mustard, Castor - cotton, sugarcane, tobacco

UNIT V IDM of fruits and vegetable crops

IDM in important crops- major fruit crops and vegetable crops.

Practical

Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM; demonstration of IDM in certain crops as project work.

Theory Schedule

1. Introduction and definition of IDM
2. Concepts of integrated disease management
3. Tools of integrated disease management
4. Components of integrated disease management
5. Limitations and implications of integrated disease management
6. Development of IDM
7. Basic principles of integrated disease management
8. Biological control of plant diseases
9. Methods of application of bio control agents
10. Botanicals in plant disease management
11. Chemicals in plant disease management
12. Classification of fungicides
13. Methods of application of fungicides
14. Exclusion of plant diseases
15. Cultural practices in plant disease management
16. Mechanical and physical methods in plant disease management
17. Biotechnological techniques to crop disease management
18. Resistance breeding in plant disease management

19. Molecular techniques and tools in IDM
20. **Mid semester examination**
21. IDM in rice
22. IDM in wheat
23. IDM in pearl millet
24. IDM in sorghum, maize
25. IDM in Bengal gram, Red gram
26. IDM in black and green gram
27. IDM in Groundnut
28. IDM in Sunflower, Sesame & Castor
29. IDM in cotton
30. IDM in sugarcane
31. IDM in fruit crops
32. IDM in fruit crops
33. IDM in vegetable crops
34. IDM in vegetable crops

Practical Schedule

1. Methods of application of bio control agents
2. Cultural operations in plant disease management
3. Cultural operations in plant disease management
4. Chemicals in plant disease management
5. Methods of application of fungicides
6. Special method of application of fungicides
7. Evaluation of compatibility
8. Botanicals in plant disease management
9. Field trip
10. Biotechnological techniques in crop disease management
11. Demonstration of IDM in rice
12. Demonstration of IDM in cotton
13. Demonstration of IDM in vegetable crops
14. Field trip
15. Demonstration of IDM in fruit crops
16. Demonstration of IDM in fruit crops
17. Record certification

Course Outcome

- CO 1** Knowing the current innovative plant disease management practices
CO 2 Being updated with various principles of plant disease management
CO 3 Trained in IDM Practices in cereals and pulses crops
CO 4 Trained in IDM Practices in oilseeds and cash crops
CO 5 Trained in IDM Practices in fruits and vegetable crops

CO – PSO – PO Mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1			×				×	×								
CO 2		×	×				×	×								
CO 3		×	×							×	×	×			×	×
CO 4		×	×							×	×	×			×	×
CO 5		×	×							×	×	×			×	×

References

1. Gupta VK & Sharma RC. (Eds). 1995. *Integrated Disease Management and Plant Health*. Scientific Publ., Jodhpur
2. Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases*. Daya Publ. House, New Delhi
3. Sharma RC & Sharma JN. (Eds). 1995. *Integrated Plant Disease Management*. Scientific Publ., Jodhpur

PAT 815 Biological control of soil borne pathogens (2+1)

Learning Objectives

- To study the concepts of Biological control
- To study the Suppressive soil and Competitive saprophytic ability
- To study the soil fungistasis
- To study the Mechanisms of Biological control
- To study the formulations of Bio control agents

Theory

Unit I Introduction

Biological control – Milestones and concepts – Ecology of soil borne pathogens – Suppressive and conductive soils – General and specific suppression – Mode of survival of pathogens, longevity and their distribution

Unit II Factors affecting abiotic and inoculum potential

Factors affecting biological agents – pathogens in relation to soil moisture, temperature, soil pH – influence of organic matter and fertility on soil borne pathogens and antagonists – inoculum potential and competitive saprophytic ability

Unit III Soil fungistasis and effect of agro chemicals and fertilizers

Soil fungistasis – influence of root exudates on establishment of pathogen and antagonists – influence of rhizosphere microflora on soil borne pathogens and antagonists – effect of agrochemicals and fertilizers on soil borne pathogens and antagonists

Unit IV Mechanism of biocontrol

Mechanism of biocontrol – competition, antibiosis, lysis, hyper parasitism and induced systemic resistance – Biological control of soil borne pathogens with Actinobacteria, Yeast and AM fungi

Unit V Delivery system and formulation of biocontrol agent

Biological control with PGPR – Endophytes, Non endophytes – Delivery system of fungal and bacterial antagonists – Commercial formulation of biocontrol agent

Practical

Rhizosphere soil – isolation and assessment of soil-borne pathogens and antagonists – methods of testing in vitro antagonism – assay of competitive saprophytic ability, antibiotics production, siderophores production, lytic enzymes – β 1,3-glucanase – cello bio hydrolase – isolation of mycorrhiza and establishing its biocontrol potentiality – compatibility of agrochemicals with bio inoculants

Theory schedule

1. Introduction of Biological control
2. Important milestones of Biocontrol agent
3. Concepts of antagonists
4. Ecology of soil borne pathogens
5. Suppressive and conductive soils
6. General and specific suppression
7. Mode of survival of pathogens, longevity and their distribution
8. Factors affecting biological agents

9. Pathogens in relation to soil moisture, temperature, soil pH
10. Influence of organic matter
11. Fertility on soil borne pathogens and antagonists
12. Inoculum potential
13. Competitive saprophytic ability
- 14. Mid semester examination**
15. Soil fungi stasis
16. Influence of root exudates on establishment of pathogen and antagonists
17. Influence of rhizospheric microflora on soil borne pathogens
18. Influence of rhizospheric microflora on soil borne antagonists
19. Effect of agrochemicals on soil borne pathogens
20. Effect of fertilizers on soil borne pathogens
21. Effect of agrochemicals on soil borne antagonists
22. Mechanism of biocontrol
23. Competition, antibiosis
24. Lysis
25. Hyper parasitism and induced systemic resistance
26. Biological control of soil borne pathogens with Actinobacteria
27. Yeast and AM fungi
28. Biological control with PGPR
29. Endophytes
30. Non endophytes
31. Delivery system of fungal antagonists
32. Delivery system of Bacterial antagonists
33. Commercial formulation of biocontrol agent
34. Commercial formulation of biocontrol agent

Practical Schedule

Rhizosphere soil – isolation and assessment of soil-borne pathogens and antagonists – methods of testing in vitro antagonism – assay of competitive saprophytic ability, antibiotics production, siderophores production, lytic enzymes – 1,3-glucanase – cellobiohydrolase – isolation of mycorrhiza and establishing its biocontrol potentiality – compatibility of agrochemicals with bio inoculants

1. Introduction of biocontrol agents
2. Isolation of fungal biocontrol agents from Rhizosphere soil
3. Isolation of bacterial biocontrol agents from Rhizosphere soil
4. Isolation and assessment of soil-borne pathogens
5. Purification of fungal biocontrol agent
6. Purification of bacterial biocontrol agents
7. Methods of testing in vitro antagonism
8. Assay of competitive saprophytic ability
9. Assay of Antibiotics production
10. Assay of Siderophores production
11. Assay of Lytic enzymes
12. Assay of β 1,3-glucanase

13. Assay of Cello bio hydrolase
14. Isolation of mycorrhiza
15. Establishing its biocontrol potentiality
16. Compatibility of agrochemicals with bio inoculants
17. Record submission

Course Outcome

- CO 1 Knowing the Longevity of plant pathogens
 CO 2 Being updated with inoculum potential of plant pathogens
 CO 3 Being updated with the soil rhizosphere microbial genera
 CO 4 Knowing the lysis, hypovirulence and cross protection
 CO 5 Knowing the commercial formulations of Bio fungicides and their trade names

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1		x		x			x	x								
CO 2		x		x			x	x								
CO 3		x		x					x			x			x	x
CO 4		x		x					x			x			x	x
CO 5		x		x					x			x			x	x

References

1. Baker KF & Snyder WC. 1965. *Ecology of Soil-borne Plant Pathogens*. John Wiley, New York.
2. Cook RJ & Baker KF. 1983. *The Nature and Practice of Biological Control of Plant Pathogens*. APS, St Paul, Minnesota.
3. Garret SD. 1970. *Pathogenic Root-infecting Fungi*. Cambridge Univ. Press, Cambridge, New York.
4. Hillocks RJ & Waller JM. 1997. *Soil-borne Diseases of Tropical Crops*. CABI, Wallington.
5. Parker CA, Rovira AD, Moore KJ & Wong PTN. (Eds). 1983. *Ecology and Management of Soil-borne Plant Pathogens*. APS, St. Paul, Minnesota.

PAT 821 ADVANCES IN VIROLOGY (2+1)

Learning Objectives

- To study the Mechanism of virus transmission by vectors, virus-vector relationship
- To study the Properties, use of monoclonal antibodies in identification of viruses
- To study the transcription and translational strategies of pararetroviruses and gemini viruses
- To study the Genetics of plant viruses
- To study the Principles of management of virus diseases.

Theory

UNIT I

Mechanism of virus transmission by vectors, virus-vector relationship, bimodal transmission and taxonomy of vectors and viruses, vector specificity for classes of viruses, virus replication, assembly and architecture, ultrastructural changes due to virus infection, variation, mutation and virus strains.

UNIT II

Immunoglobulin structure and functions of various domains, methods of immunodiagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, Polymerase chain reaction.

UNIT III

Genome organization, replication, transcription and translational strategies of pararetroviruses and gemini viruses, satellite viruses and satellite RNA genome organization in tobamo-, poty-, bromo, cucummo, ilar and tospoviruses.

UNIT IV

Gene expression and regulation, viral promoters, molecular mechanism of host virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroids and prions.

UNIT V

Genetic engineering with plant viruses, viral suppressors, a RNAi dynamics, resistant genes. Viruses potential as vectors, genetically engineered resistance, transgenic plants. Techniques and application of tissue culture. Origin, evolution and inter-relationship with animal viruses.

Practical

Purification of virus(es). SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation, serological techniques (i) DAC-ELISA (ii) DAS -ELISA (iii) DIB A (iv) Western blots (v) (ab) 2-ELISA, vector transmission (one each with aphid, leaf hopper and whitefly), methods for collecting vectors and their maintenance, nucleic acid isolation, DOT-blot, southern hybridization, probe preparation and autoradiography, PCR application and viral genome cloning, sequencing annotation of genes.

Theory Schedule

- 1 Landmarks and economic importance of Plant Virology
- 2 Symptoms of plant viral diseases
- 3 Transmission of viruses
- 4 Virus vector relationship
- 5 Taxonomy of vectors and viruses
- 6 Virus architecture, replication and assembly
- 7 Ultrastructural changes due to virus infection

- 8 Changes due to variation, mutation and virus strains,
- 9 Immunoglobulin structure and functions
- 10 Methods of Immunodiagnosis
- 11 Hybridoma technology
- 12 Monoclonal , polyclonal antibodies
- 13 Role of monoclonal antibodies in identifying viral strains
- 14 ELISA, PCR
- 15 Genome, genome organisation
- 16 Genome replication, transcription and translation – Pararetroviruses
- 17 Genome replication, transcription and translation – Gemini viruses
- 18 Satellite viruses
- 19 RNA genome organization in tobamo and poty viruses
- 20 RNA genome organization in bromo, cucumo, ilar and tospo viruses
- 21 Gene expression and regulation
- 22 Molecular mechanism of host virus interactions
- 23 Molecular mechanism of vector transmission
- 24 Viral promoters, virus induced gene
- 25 Symptom expression
- 26 Viroids and prions
- 27 Genetic engineering with plant viruses
- 28 Viral suppressors and resistant genes
- 29 Virus potential as vectors
- 30 Genetically engineered resistance
- 31 Transgenic plants
- 32 Techniques and application of tissue culture
- 33 Origin and evolution of plant viruses
- 34 Interrelationship with animal viruses.

Practical Schedule

- 1 Purification of viruses
- 2 SDS-PAGE (determination of molecular weight of viral proteins)
- 3 Production of polyclonal antiserum
- 4 Serological techniques – DAC-ELISA, DAS-ELISA.
- 5 DIBA, Western blots
- 6 Collection of vectors- Methods
- 7 Field trip
- 8 Vector transmission assay
- 9 Vector transmission assay
- 10 Vector transmission assay
- 11 Vectors-Maintenance and nucleic acid isolation.
- 12 DOT-blot, Southern hybridization
- 13 Probe preparation and autoradiography
- 14 PCR application
- 15 Viral genome cloning, sequencing annotation of genes
- 16 Field trip – Visit to a renowned virology laboratory.
- 17 Record Certification

Course Outcome

- CO 1** Knowledge in the Mechanism of virus transmission by vectors, virus-vector relationship
- CO 2** Aware of the Properties of virus, use of monoclonal antibodies in identification of viruses
- CO 3** Knowledge of the transcription and translational strategies of pararetroviruses and Gemini viruses

- CO 4** Knowledge of the Genetics of plant viruses
CO 5 Knowledge of the Principles of management of virus diseases

CO – PSO – PO Mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1		×		×			×	×								
CO 2		×		×			×	×								
CO 3		×		×					×			×			×	×
CO 4		×		×					×			×			×	×
CO 5		×		×					×			×			×	×

References

1. Davies 1997. *Molecular Plant Virology: Replication and Gene Expression*. CRC Press, Florida.
2. Fauquet *et al.* 2005. *Virus Taxonomy*. VIII Report of ICTV. Academic Press, New York.
3. Gibbs A & Harrison B. 1976. *Plant Virology - The Principles*. Edward Arnold, London.
4. Jones P, Jones PG & Sutton JM. 1997. *Plant Molecular Biology: Essential Techniques*. John Wiley & Sons, New York.
5. Matthews, R.E.F. 1991 *Plant Virology*, Academic Press, New York.

PAT 822 ADVANCES IN BACTERIOLOGY (2+1)

Learning Objectives

- To study the new classification of plant pathogenic bacteria
- To study the Morphology and physiology of bacteria
- To study the Nucleic acid based detection of plant pathogenic bacteria
- To study the plant pathogenic bacterial pathogenesis
- To study the Bacterial diseases and their management practices

Theory

UNIT I

Current approaches for the characterization and identification of phytopathogenic bacteria. Ultrastructures and biology of bacteria. Current trends in taxonomy of phytopathogenic prokaryotes

UNIT II

Role of enzyme, toxin, exopolysaccharide, polypeptide signals in disease development. Mechanism of wilt (*Ralstonia solanacearum*) development, mechanism of soft rot (*Erwinia* spp.) development, mechanism of Crown gall formation (*Agrobacterium tumefaciens*).

UNIT III

Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type **III** secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein.

UNIT IV

Molecular variability among phytopathogenic prokaryotes and possible host defense mechanism(s). Genetic engineering for management of bacterial plant pathogens- gene silencing, RNAi technology.

UNIT V

Epidemiology in relation to bacterial plant pathogens. Development of diagnostic kit. Beneficial prokaryotes- endophytes, PGPR, phylloplane bacteria and their role in disease management. Endosymbionts for host defence.

Practical

Pathogenic studies and race identification; plasmid profiling of bacterial fatty acid profiling of bacteria; RAPD profiling of bacteria and variability status; Endospore, Flagler staining; test for secondary metabolite production, cyanides, EPS, siderophore: specific detection of phytopathogenic bacteria using species/pathovar specific primers. Basic techniques in diagnostic kit development, molecular tools to identify phytoendosymbionts

Theory Schedule

- 1 Current approaches in identification of phytopathogenic bacteria
- 2 Current approaches in characterisation of phytopathogenic bacteria
- 3 Anatomy and ultra structures of bacteria
- 4 Biology of bacteria
- 5 Endospore – multiplication
- 6 Taxonomy of phytopathogenic prokaryotes
- 7 Current trends in taxonomy of phytopathogenic bacteria
- 8 Role of toxin and enzyme in disease development
- 9 Role of exopolysaccharides in disease development
- 10 Role of polypeptide signals in disease development
- 11 Mechanism of wilt (*Ralstonia solanacearum*) development
- 12 Mechanism of soft rot (*Erwinia* sp.) development
- 13 Mechanism of crown gall formation (*Agrobacterium tumefaciens*)
- 14 Host- bacterial pathogen interaction

- 15 Quorum sensing phenomenon
- 16 Type III secretion system
- 17 HR/SR reactions
- 18 R-genes, Avr-genes, hrp genes
- 19 Effector proteins
- 20 Mid semester exam
- 21 Molecular variability among phytopathogenic prokaryotes
- 22 Host defense mechanism
- 23 Genetic engineering for management of bacterial plant pathogens
- 24 Gene-silencing
- 25 RNAi technology
- 26 Epidemiology
- 27 Epidemiology in relation to bacterial plant pathogens
- 28 Forecasting
- 29 Development of diagnostic kit
- 30 Beneficial prokaryotes
- 31 Beneficial endophytes
- 32 PGPR
- 33 Phylloplane bacteria and their role in disease management
- 34 Endosymbionts

Practical schedule

- 1 Pathogenic studies
- 2 Race identification
- 2 Plasmid profiling of bacteria
- 3 Fatty acid profiling of bacteria
- 4 RAPD profiling of bacteria
- 5 Formation of endospore
- 6 Flagellar staining
- 7 Test for secondary metabolite production, test for cyanides, EPS
- 8 Field trip
- 9 Test for production of siderophore
- 10 Specific detection of phytopathogenic bacteria using specific primers
- 11 Specific detection of phytopathogenic bacteria using specific primers
- 12 Specific detection of phytopathogenic bacteria using specific primers
- 13 Basic techniques in diagnostic kit development
- 14 Field trip
- 15 Tools to identify phylloplane bacteria
- 16 Molecular tools to identify phytoendosymbionts.
- 17 Record certification

Course Outcome

- CO 1** Having knowledge about different types of classification and new Nomenclature of phyto- pathogenic bacteria
- CO 2** Plant pathogenic bacteria and bacterial secretion systems
- CO 3** Having knowledge about plant pathogenic bacterial pathogenesis and physiology
- CO 4** Knowing bacterial Hrp genes and new innovative techniques of plant pathogenic bacteria detection
- CO 5** Updated knowledge about pathogenesis of bacterial diseases and Integrated disease management

CO – PSO – PO Mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1				×			×	×								
CO 2		×					×	×								
CO 3		×	×									×	×		×	×
CO 4		×		×								×	×		×	×
CO 5		×									×	×			×	×

References

1. Dale J W & Simon P. 2004. *Molecular Genetics of Bacteria*. John Wiley & Sons, New York.
2. v GM, Krieg NR & Brenner DJ. 2006. *Bergey's Manual of Systematic Bacteriology: The Proteobacteria*. Vol. II. SpringerVerlag, New York.
3. Gnanamanickam SS. 2006. *Plant-Associated Bacteria*. Springer Verlag, New York.
4. Jayaraman, J & Verma, JP. 2002. *Fundamentals of Plant Bacteriology*, Kalyani Publ. Ludhiana
5. Mount MS & Lacy GH. 1982. *Plant Pathogenic Prokaryotes*. Vols. I, II. Academic Press, New York.
6. Sigeo DC. 1993. *Bacterial Plant Pathology: Cell and Molecular Aspects*. Cambridge Univ. Press, Cambridge
7. Starr MP. 1992. *The Prokaryotes*. Vols. I - IV. Springer Verlag, New York.
8. Verma JP, 1998. *The Bacteria*. Malhotra Publ. House, New Delhi.

PAT 823 POST HARVEST PATHOLOGY AND MUSHROOM PRODUCTION (2+1)

Learning Objectives

- To study the Economic importance of seed borne diseases
- To study the Seed certification standard
- To study the Post harvest pathology
- To study the Post harvest diseases management
- To study the Mushroom cultivation

Theory

Unit – I Introduction to Seed Pathology

Problems and prospects of seed pathology – Economic importance of seed-borne diseases–Significance of seed transmission compared to other means – Infection of seeds – Location and survival of inoculum – Longevity of seed borne organisms – Seed contamination.

Unit – II Seed certification and storage

Quarantine for seed – Disease-free seed production and certification – Seed act – Global seed trade, Phytosanitary certificates under WTO and TRIPS – Pest Risk Analysis – Seed quality – Storage and field fungi – mycotoxins – Storage methods detection of seed-borne organisms – Seed certification standards, Seed health testing – Seed crop management.

Unit – III Introduction to post-harvest pathology

Post-harvest loss – Definition – Deterioration of fruits and vegetables – Nature and kind of post-harvest loss – Types of post-harvest problems both by biotic and abiotic causes, rhizosphere colonization, microbial associations, concept, operational mechanisms and its relevance in control. Estimation of post-harvest loss – Pathogenicity – Field fungi and storage fungi– Biological and environmental causes of losses, their significance in grain and horticultural produce – Mycotoxins – Post-harvest diseases caused by fungi and bacteria in fruits – Post-harvest diseases in transit and storage.

Unit – IV Management of post-harvest disease

Strategies of plant defenses – Aflatoxins and their integrated management. Methods for the management of post-harvest diseases– Biological control of post-harvest diseases in fruits and vegetables –Physical, chemical and natural fungicides for management of post-harvest diseases – Merits and demerits – Application and use of post-harvest fungicides – Integrated approach in controlling diseases and improving the shelf life of produce–Application and monitoring for any health hazard, knowledge of Codex Alimentarius for each product and commodity.

Unit – V Mushroom production

Mushroom science: Importance, related fields and their contribution global production– Morphology and life cycle: *Pleurotus*, *Calocybe*, *Agaricus* and *Volvariella*. Poisonous mushrooms. Cultivation: oyster mushroom, milky mushroom, paddy straw mushroom, button mushroom and other edible mushrooms. Problems in cultivation: weed moulds, diseases, pests and abiotic disorders.

Practical

Seed sampling and dry seed examinations - Seed washing techniques - Incubation methods - Detection of seed-borne pathogens by non-destructive method - Determination of seed quality - Physical, chemical and biological methods of controlling seed-borne pathogens - Estimation of mycotoxin (Aflatoxin) from infested seeds - Major post-harvest diseases of fruits and vegetables - Assessment of loss due to post-harvest diseases - Cultivation of oyster mushroom, milky, paddy straw and button mushroom.

Theory Schedule

1. Economical Importance of seed pathology
2. History of seed pathology
3. Problems and prospects of seed pathology
4. Significance of seed transmission
5. Infection of seeds
6. Location and survival of inoculum
7. Longevity of seed borne organisms
8. Seed contamination
9. Plant Quarantine
10. Quarantine for seed
11. Disease-free seed production and certification
12. Seed act - Global seed trade, Phytosanitary certificates under WTO and TRIPS
13. Pest Risk Analysis and Seed quality
14. Storage and field fungi
15. Mycotoxins
16. Storage methods detection of seed-borne organisms and Seed certification standards, Seed health testing – Seed crop management.
17. **Mid-semester Examinations**
18. Post-harvest loss
19. Deterioration of fruits and vegetables
20. Nature and kind of post-harvest loss
21. Types of post-harvest problems both by biotic and abiotic
22. Estimation of post-harvest loss and Pathogenicity
23. Field fungi and storage fungi and Biological and environmental causes of losses
24. Post-harvest diseases caused by fungi and bacteria in fruits and Post-harvest diseases in transit and storage.
25. Strategies of plant defenses Aflatoxins and their integrated management
26. Methods for the management of post-harvest diseases
27. Biological control of post-harvest diseases in fruits and vegetables, Physical, chemical and natural fungicides for management of post-harvest diseases, Merits and demerits
28. Application and use of post-harvest fungicides
29. Integrated approach in controlling diseases and improving the shelf life of produce

30. Application and monitoring for any health hazard, knowledge of Codex Alimentarius for each product and commodity.
31. Mushroom science: Importance, related fields and their contribution global production and Morphology
32. Life cycle of *Pleurotus*, *Calocybe*, *Agaricus* and *Volvariella* and Poisonous mushrooms
33. Cultivation of oyster mushroom, milky mushroom, paddy straw mushroom.
34. Cultivation of button mushroom and other edible mushrooms: Pest and diseases of mushroom

Practical Schedule

1. Seed sampling and dry seed examinations.
2. Physical purity, analysis of seed samples for seed discolouration abnormalities, fungal structures, galls, plant parts and inert matters.
3. Seed washing techniques: Examinations of seed wash, enumeration and estimation of important seed-borne organisms.
4. Incubation methods: Blotter method, 2,4-D blotter method, deep freezing method and agar plate method.
5. Detection of seed-borne pathogens by non-destructive method.
6. Determination of seed quality: Growing on test, roll towel method and sand method and testing of treated seed (biological method).
7. Physical, chemical and biological methods of controlling seed-borne pathogens.
8. Estimation of mycotoxin (Aflatoxin) from infested seeds.
9. Visit to seed production field, seed testing laboratory, seed godowns and warehouses.
10. Major post-harvest diseases of fruits and vegetables: fruit spots, blight, soft rot, anthracnose.
11. Spoilage of grains in storage.
12. Field fungi and storage fungi in horticultural crops.
13. Assessment of loss due to post-harvest diseases.
14. Visit to local market to study spoilage of fruits and vegetables.
15. Cultivation of oyster mushroom and milky mushroom
16. Cultivation of paddy straw mushroom and button mushroom
17. Record Certification

Course Outcome

- CO 1 Knowing the Longevity of seed borne pathogens
- CO 2 Being updated with Seed act and rules
- CO 3 Being updated with Post harvest diseases
- CO 4 Knowing the Post harvest fungicides
- CO 5 Knowing the Medicinal values of Mushroom

CO – PSO – PO Mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1			×	×								×
CO 2						×	×					×
CO 3			×	×			×	×		×	×	
CO 4			×	×			×	×	×	×	×	
CO 5						×				×		×

Reference Books

1. Agarwal, V.K. 1988. Principles of Seed Pathology, CRC Publication.
2. Anna Snowden 2001. A Colour Atlas of Post-Harvest Diseases and Disorders of Fruits and Vegetables. Volume 1. General Introduction and Fruits. Iowa State University Press.
3. Anna Snowden 2001. A Colour Atlas of Post-Harvest Diseases and Disorders of Fruits and Vegetables. Volume 2. Vegetables. Iowa State University Press.
4. Barkai-Golan, R. and Paster, N. 2011. Mycotoxins in Fruits and Vegetables. Academic Press.
5. Hall, I.R., Stephenson, S.L., Buchanan, P.K., Yun, W. and Cole, A.L.J. 2003. Edible and Poisonous Mushrooms of the World. Timber Press.
6. Karuna Vishunavat 2016. Fundamentals of Seed Pathology. Kalyani publishers
7. Neergaard, P. 1987. Seed Pathology. Macmillan Publication.
8. Prusky, D. and Gullino, M.L. 2014. Plant Pathology in 21st Century - Post Harvest Pathology. Springer Publication.
9. Suman, B.C. and Sharma, V. P. 2007. Mushroom Cultivation in India. Daya Publishing House.
10. Susamma Philip 2014. Management of Post-Harvest Diseases of Fruits, Vegetables and Tuber Crops. ICAR Publications.

e-References

1. <https://www.mushroomcouncil.com>
2. postharvest.tfrec.wsu.edu
3. <https://fungiforthepeople.org>
4. http://agritech.tnau.ac.in/crop_protection/crop_prot.html
5. <https://www.seedtest.org/>

PAT 824 Advances in Biological Control of Plant Diseases (2+1)

Learning Objectives

- To study the Economic importance of seed borne diseases
- To study the Seed certification standard
- To study the Post harvest pathology
- To study the Post harvest diseases management
- To study the Mushroom cultivation

Theory

Unit I Introduction

Biological control – Milestones and concepts – Ecology of soil borne pathogens – Suppressive and conducive soils – General and specific suppression – Mode of survival of pathogens, longevity and their distribution

Unit II Factors affecting abiotic and inoculum potential

Factors affecting biological agents – pathogens in relation to soil moisture, temperature, soil pH – influence of organic matter and fertility on soil borne pathogens and antagonists – inoculum potential and competitive saprophytic ability

Unit III

Soil fungistasis – influence of root exudates on establishment of pathogen and antagonists – influence of rhizosphere microflora on soil borne pathogens and antagonists – effect of agrochemicals and fertilizers on soil borne pathogens and antagonists

Unit IV Mechanism of biocontrol

Mechanism of biocontrol – competition, antibiosis, lysis, hyper parasitism and induced systemic resistance – Biological control of soil borne pathogens with Actinobacteria, Yeast and AM fungi

Unit V Delivery system and formulation of biocontrol agent

Biological control with PGPR – Endophytes, Non endophytes – Delivery system of fungal and bacterial antagonists – Commercial formulation of biocontrol agent

Practical

Rhizosphere soil – isolation and assessment of soil-borne pathogens and antagonists – methods of testing in vitro antagonism – assay of competitive saprophytic ability, antibiotics production, siderophores production, lytic enzymes – β 1,3-glucanase – cellobiohydrolase – isolation of mycorrhiza and establishing its biocontrol potentiality – compatibility of agrochemicals with bio inoculants

Theory schedule

35. Introduction of Biological control
36. Important milestones of Biocontrol agent
37. Concepts of antagonists
38. Ecology of soil borne pathogens
39. Suppressive and conducive soils
40. General and specific suppression
41. Mode of survival of pathogens, longevity and their distribution
42. Factors affecting biological agents
43. Pathogens in relation to soil moisture, temperature, soil pH

44. Influence of organic matter
45. Fertility on soil borne pathogens and antagonists
46. Inoculums potential
47. Competitive saprophytic ability

48. Mid semester examination

49. Soil fungi stasis
50. Influence of root exudates on establishment of pathogen and antagonists
51. Influence of rhizosphermicroflora on soil borne pathogens
52. Influence of rhizosphermicroflora on soil borne antagonists
53. Effect of agrochemicals on soil borne pathogens
54. Effect of fertilizers on soil borne pathogens
55. Effect of agrochemicals on soil borne antagonists
56. Mechanism of biocontrol
57. Competition, antibiosis
58. Lysis
59. Hyper parasitism and induced systemic resistance
60. Biological control of soil borne pathogens with Actinobacteria
61. Yeast and AM fungi
62. Biological control with PGPR
63. Endophytes
64. Non endophytes
65. Delivery system of fungal antagonists
66. Delivery system of Bacterial antagonists
67. Commercial formulation of biocontrol agent
68. Commercial formulation of biocontrol agent

Practical Schedule

Rhizosphere soil – isolation and assessment of soil-borne pathogens and antagonists – methods of testing in vitro antagonism – assay of competitive saprophytic ability, antibiotics production, siderophores production, lytic enzymes – 1,3-glucanase – cello bio hydrolase – isolation of mycorrhiza and establishing its biocontrol potentiality – compatibility of agrochemicals with bio inoculants

1. Introduction of biocontrol agents
2. Isolation of fungal biocontrol agents from Rhizosphere soil
3. Isolation of bacterial biocontrol agents from Rhizosphere soil
4. Isolation and assessment of soil-borne pathogens
5. Purification of fungal biocontrol agent
6. Purification of bacterial biocontrol agents
7. Methods of testing in vitro antagonism
8. Assay of competitive saprophytic ability
9. Assay of Antibiotics production
10. Assay of Siderophores production
11. Assay of Lytic enzymes
12. Assay of β 1,3-glucanase
13. Assay of Cello bio hydrolase
14. Isolation of mycorrhiza

15. Establishing its biocontrol potentiality
16. Compatibility of agrochemicals with bio inoculants
17. Record submission

Course Outcome

- CO 1** Knowing the Longevity of seed borne pathogens
CO 2 Being updated with Seed act and rules
CO 3 Being updated with Post harvest diseases
CO 4 Knowing the Post harvest fungicides
CO 5 Knowing the Medicinal values of Mushroom

CO – PSO – PO Mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1				×			×	×				×				
CO 2						×	×	×							×	
CO 3		×					×	×				×				×
CO 4		×					×	×				×				×
CO 5						×	×	×			×	×				×

References

1. Baker KF & Snyder WC. 1965. *Ecology of Soil-borne Plant Pathogens*. John Wiley, New York.
2. Cook RJ & Baker KF. 1983. *The Nature and Practice of Biological Control of Plant Pathogens*. APS, St Paul, Minnesota.
3. Garret SD. 1970. *Pathogenic Root-infecting Fungi*. Cambridge Univ. Press, Cambridge, New York.
4. Hillocks RJ & Waller JM. 1997. *Soil-borne Diseases of Tropical Crops*. CABI, Wallington.
5. Parker CA, Rovira AD, Moore KJ & Wong PTN. (Eds). 1983. *Ecology and Management of Soil-borne Plant Pathogens*. APS, St. Paul, Minnesota.