



**ANNAMALAI UNIVERSITY**

(Accredited with 'A' Grade by NAAC)

**FACULTY OF AGRICULTURE**

(Accredited by ICAR)



**DEPARTMENT OF PLANT PATHOLOGY**

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**Academic Regulations and Syllabi**

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**DOCTOR OF PHILOSOPHY IN  
PLANT PATHOLOGY**

**Under Choice based credit system  
(CBCS) with Outcome based Education**

**2019-2020 Onwards**

# 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 consist 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**

<b>Doctoral Degree Programmes</b>	<b>Eligibility</b>
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
	<b>Total</b>	<b>75</b>

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:

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



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**

- a) 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 .
- b) 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.
- c) 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.
- d) 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:

- a) Earn a Grade Point of 7.00 for a pass in each subject.
- b) 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:

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

## **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

<b>Semester</b>	<b>Credit Hours</b>
I Semester	0+1
II Semester	0+2
III Semester	0+12
IV Semester	0+12
V Semester	0+9
VI Semester	0+9
<b>Total</b>	<b>0+45</b>

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 evaluation.

### **13.1 Pre-submission Presentation**

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

### **13.2 Submission of Synopsis**

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

### **13.3 Guidelines for Preparation of Thesis**

1. The thesis shall not exceed 250 pages excluding the Bibliography, Appendices, etc. If it exceeds the specified number of pages, the Research Supervisor should write to University with the reasons and get prior approval from the University. The candidate shall pay a penalty for the excess number of pages as decided by the Deans Committee. The thesis should be in A4 size. The specification for the preparation of the thesis are given in Annexure-7. A model cover page for a thesis is given in Annexure -8.
2. The thesis shall be typed on both sides of the page in order to save paper and postage
3. The thesis shall contain a Certificate from the guide (Annexure-9) specifying that the thesis submitted is a record of research work done by the candidate during the period of study under him/her and that the thesis has not previously formed the basis for the award of any Degree, Diploma, Associateship, Fellowship or similar title. A statement from the guide indicating the extent to which the thesis represents independent work on the part of the candidate should also be made.
4. The thesis shall also contain a Declaration by the candidate (Annexure -10) that the work reported in the thesis has been carried out by the candidate himself/herself and that the material from other sources, if any, is duly acknowledged and no part of the thesis is plagiarized.



#### **14. VALUATION OF THE THESIS Panel Of Examiners**

The thesis submitted in partial fulfillment of the Ph.D. degree shall be evaluated by two external experts one from within the country and the other from outside the country appointed by the Vice-Chancellor on the recommendation of the research supervisor of the RAC, HOD and Dean. They shall be chosen from a panel of at least five names of specialists separately from within the country and outside the country in the particular field, suggested by the research supervisor. The external experts shall send their evaluation reports of the thesis directly to the Director, CARE along with the copy of the evaluated thesis. The Director, CARE on receipt of the reports from the two examiners will send them to the concerned guide who is the convener of viva-voce board. The guide will send the consolidated report with his remarks to the Director, CARE through the Head of the Department. On the satisfactory reports of the evaluation, viva-voce examination will be arranged.

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

##### **14.2. Revision and Resubmission of Thesis**

- i. If an examiner recommends change / further work, the thesis will be referred to the same examiner after compliance for his opinion. In case of rejection by any one of the examiners, the thesis will be sent to another examiner and his / her recommendation will be final.
- ii. If the thesis is recommended to be revised by one or both examiners, the points of revision will be indicated clearly in the report. The necessary correction should be carried out, and the revised version should be sent to the concerned examiner(s). If the examiner(s) is / are still not satisfied with the revised version, the thesis will be rejected. If the thesis is accepted by the examiners (Evaluation), Viva-Voce examination will be conducted by the viva-voce board.

##### **14.3. Re-registration and Submission of Thesis**

The minimum of 80% attendance requirement for submitting the thesis after re-registration need not be insisted for those students who have fulfilled the minimum academic and residential requirement of 3 or 4 years.

#### **14.4. Extension of Time**

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

#### **14.5. Number of Chances**

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

#### **15. DISCONTINUANCE AND READMISSION**

- 15.1.** Students admitted to the PhD degree who discontinue their studies before completing the degree with written permission from the University may be re-admitted to the degree programme, provided that the student should have completed the course work before such discontinuance. However the period of such discontinuance should not exceed five years for Ph.D. Degree from date of admission.
- 15.2.** After completion of course work and qualifying examination, a student is eligible to discontinue temporarily his research program only once within 5 years for PhD program. If the discontinuation period exceeds two semesters, the student has to forego the research credits already registered and register afresh with revised program. In the case of field experiments or laboratory experiments in which continuity is essential for research and if a student temporarily discontinues in the middle without completing the experiments, then the entire experiment should be repeated even if the discontinuation period does not exceed two semesters.
- 15.3.** A student joining the studies, after discontinuation should pay the fees of the existing semester.

#### **16. PUBLICATION OF THE THESIS**

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

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

## **DEPARTMENT OF PLANT PATHOLOGY**

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

#### **Ph.D. Plant Pathology**

##### **Programme Outcomes**

A Doctorate degree in Plant Pathology prepares the students,

- PO 1** For a career with advanced research capabilities and effective teaching skills
- PO 2** With clear knowledge on molecular plant microbe interactions and plant innate immunity
- PO 3** With awareness on the relationship of diseases with environment and designing management strategies
- PO 4** With in-depth knowledge on Molecular detection and diagnosis of Biotic and Mesobiotic pathogens
- PO 5** With understanding on Epidemiological forecasting and simulation models
- PO 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**

<b>Sl. No.</b>	<b>Course No.</b>	<b>Course Title</b>	<b>Credit Hours</b>
<b>MAJOR COURSES</b>			
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
<b>MINOR COURSES</b>			
1.	PAT 815	Biological control of soil borne pathogen ( for other departments )	2+1
2.	PAT 825	Mushroom technology ( for other departments )	2+1
3.		MOCC / SWYAM	2 + 0
<b>SUPPORTING COURSES</b>			
1.	COM 811	Advances in computer application	0 + 1
2.	LIS 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 80X	Research	0 + 45
		<b>Total</b>	<b>16 + 59 = 75</b>

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

Course No.	Course Title	Credit Hours
<b>Semester - I</b>		
<b>Major Courses</b>		
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
<b>Minor Courses</b>		
PAT 815	Biological control of soil borne pathogens ( for other departments )	2+1
<b>Supporting Courses</b>		
COM 811**	Advances in computer application	0 + 1
LIS 812**	Advances in agricultural information retrieval (0+1)	0 + 1
PAT 801	Research	0 + 1
PAT 081	Seminar	0 + 1
<b>TOTAL</b>		<b>16 Credits</b>
<b>Semester - II</b>		
<b>Major Courses</b>		
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
<b>Minor Courses</b>		
PAT 825	Mushroom technology ( for other departments )	2 + 1
	MOCC / SWYAM	2 + 0
<b>Supporting Courses</b>		
STA 821**	Advances in Design Experiments	2 + 1
PAT 802	Research	0 + 2
PAT 082	Seminar	0 + 1
<b>TOTAL</b>		<b>17 Credits</b>
<b>Semester - III</b>		
PAT 803	Research	0 + 12
<b>Semester - IV</b>		
PAT 804	Research	0 + 12
<b>Semester - V</b>		
PAT 805	Research	0 + 12
<b>Semester - IV</b>		
PAT 806	Research	0 + 6
<b>TOTAL RESEARCH CREDITS</b>		<b>45 Credits</b>
<b>TOTAL FOR SIX SEMESTER</b>		<b>75 Credits</b>

\*\* 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.  $\beta$ -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 –PO Mapping**

	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	2	3	0	3	0	0
<b>CO 2</b>	1	3	0	3	0	0
<b>CO 3</b>	0	3	3	3	0	0
<b>CO 4</b>	3	0	3	3	0	0
<b>CO 5</b>	0	0	1	3	0	3



## 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 Molecular Biology. 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., Binghamton, 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, arthrospores. 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
17. Ultrastructure of fungi
18. Reproduction in fungi
19. Spore-producing structures of fungi

## **20. Mid semester examination**

21. Protozoa – chromista
22. Zycomycota - Ascomycota – Basidio mycota
23. Fungal population biology
24. Pathogenic variability
25. Vegetative compatibility
26. PCR based detection of fungal pathogens
27. Parasexuality
28. Heterokaryosis
29. Fungal genetics
30. Fungal biodiversity
31. Sex hormones in fungi
32. Life cycle pattern in fungi
33. Pleomorphism and speciation in fungi
34. Mechanism of nuclear and extra nuclear inheritance

## **Practical Schedule**

1. Comparative study of fungi
2. Preservation of fungi – Methods
3. Study of conidiogenesis
4. Purification of fungi
5. Microscopic observations
6. Phialides
7. Porospores
8. Arthrospores
9. Study of sexual and asexual fruiting bodies of fungi
10. Study of asexual fruiting bodies
11. Microscopic observations
12. Identification of fungi up to species level

13. Identification of fungi up to species level
14. Molecular detection
15. Study of hyphal anastomosis
16. Morphological study
17. Record certification

### Course Outcome

- CO 1** Knowing the landmarks in Mycology
- CO 2** Being updated with the recent binomial and trinomial classification of plant pathogenic fungi
- CO 3** Having in depth knowledge of the morphology and conidiogenesis of fungi
- CO 4** Knowing the pathogenic variability
- CO 5** Knowing the parasexuality, life cycle and mechanism of nuclear inheritance in fungi.

### CO – PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
<b>CO 1</b>	3	0	0	0	0	0
<b>CO 2</b>	3	2	0	0	0	0
<b>CO 3</b>	3	0	3	0	0	0
<b>CO 4</b>	3	0	0	3	0	0
<b>CO 5</b>	3	0	0	2	0	0

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5. Kirk, P. M *et al.* 2008. Dictionary of the Fungi, 10<sup>th</sup> edition, CABI Publication.
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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](http://www.indexfungaroum.org)
5. [www.mycobank.org](http://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 – PO Mapping**

	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	3	0	0	0	0	0
<b>CO 2</b>	2	3	2	2	0	0
<b>CO 3</b>	3	0	1	2	0	0
<b>CO 4</b>	3	0	3	0	3	0
<b>CO 5</b>	1	0	1	0	3	3

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3. <http://eagri.org/eagri50/PATH171/lec19.pdf>
4. [plantpath.ifas.ufl.edu](http://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 – PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
<b>CO 1</b>	3	3	0	0	0	0
<b>CO 2</b>	2	2	0	0	0	0
<b>CO 3</b>	2	2	0	0	1	3
<b>CO 4</b>	2	2	0	0	1	3
<b>CO 5</b>	2	0	0	0	1	3

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### **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 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 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 –  $\beta$ 1,3-glucanase – cellobiohydrolase – 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 conducive 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 rhizosphermicroflora on soil borne pathogens
18. Influence of rhizosphermicroflora 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 – cello bio hydrolase – isolation of mychorriza 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  $\beta$ 1,3-glucanase
13. Assay of Cello bio hydrolase
14. Isolation of mychorriza
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

### CO – PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	1	0	0	0
CO 2	1	2	3	1	0	0
CO 3	1	2	3	0	0	0
CO 4	1	1	2	0	2	3
CO 5	0	0	0	0	2	3

### References

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2. Cook RJ & Baker KF. 1983. *The Nature and Practice of Biological Control of Plant Pathogens*. APS, St Paul, Minnesota.
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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, cucummo, 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 – PO Mapping**

	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	3	0	0	0	0	0
<b>CO 2</b>	2	3	3	3	0	2
<b>CO 3</b>	0	2	1	3	0	0
<b>CO 4</b>	0	0	1	2	0	3
<b>CO 5</b>	0	0	1	3	0	3



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2. Fauquet *et al.* 2005. *Virus Taxonomy*. VIII Report of ICTV. Academic Press, New York.
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## 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 expolysaccharides 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 Flagiler 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 – PO Mapping

	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	3	2	2	1	0	0
<b>CO 2</b>	3	2	0	1	0	0
<b>CO 3</b>	3	0	2	0	0	0
<b>CO 4</b>	1	2	0	3	0	3
<b>CO 5</b>	3	2	0	0	0	3

### 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.
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7. Starr MP. 1992. *The Prokaryotes*. Vols. I - IV. Springer Verlag, New York.
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## **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 – PO Mapping**

	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	1	0	1	1	2	0
<b>CO 2</b>	1	0	1	1	0	0
<b>CO 3</b>	0	1	2	1	2	0
<b>CO 4</b>	0	0	2	0	0	0
<b>CO 5</b>	2	0	1	2	2	2

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14. [http://agritech.tnau.ac.in/crop\\_protection/crop\\_prot.html](http://agritech.tnau.ac.in/crop_protection/crop_prot.html)
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## PAT 824 Advances in Biological Control of Plant Diseases (2+1)

### Learning Objectives

- To study the history of biological control
- To study the advances in mechanisms involved in biological interactions
- To study the advances in understanding factors governing biological management
- To study the commercial production of antagonists
- To study the IPM and organic farming system

### Theory

#### Unit – I Importance of biological control

History of biological control, merits and demerits of biological management, Modern concepts of biological control, definitions, importance, principles of plant disease management with bioagents.

## **Unit – II Mechanism involved in bioagents**

Advances in mechanisms involved in biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological management.

## **Unit – III Factors governing biological management**

Advances in understanding factors governing biological interactions; role of physical environment, agroecosystem, operational mechanisms and cultural practices in biological management of pathogens. Comparative approaches to biological management of plant pathogens by resident and introduced antagonists. Operational mechanisms and its relevance in biological management.

## **Unit – IV Commercial production**

Modern concepts and advances in commercial production of antagonists, Formulations: their delivery systems and monitoring; Quality control system of biocontrol agents.

## **Unit – V IDM**

Biological control in IDM, IPM and organic farming systems; Scope of biological management of plant pathogens/diseases. Management of soil-borne and foliar diseases. Compatibility among antagonists as well as with other fungistatic/fungicide compounds. Bio-pesticides available in market.

## **Theory schedule**

1. History of biological control
2. Definitions, importance of biological control
3. Principles of plant disease management with bioagents
4. Merits and demerits of biological management
5. Modern concepts of biological control
6. Advances in mechanisms involved in biological interactions
7. Competition, mycoparasitism, exploitation for hypovirulence
8. Rhizosphere colonization
9. Competitive saprophytic ability (CSA)
10. Antibiosis and lysis
11. Induced resistance



12. Mycorrhizal associations
13. Operational mechanisms and its relevance in biological management
- 14. Mid-semester examination**
15. Advances in understanding factors governing biological management
16. Role of physical environment, agroecosystem
17. Operational mechanisms in biological management of pathogens and antagonists and their relationship
18. Cultural practices in biological management of pathogens and antagonists and their relationship
19. Biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists
20. Control of soil-borne diseases
21. Control of soil-borne diseases
22. Control of foliar diseases
23. Control of foliar diseases
24. Compatibility among different bioagents as well as with other fungistatic compounds
25. Compatibility among different bioagents as well as with other fungistatic compounds
26. Modern concepts and advances in commercial production of fungal antagonists, their delivery systems and monitoring
27. Modern concepts and advances in commercial production of bacterial antagonists, their delivery systems and monitoring
28. Modern concepts and advances in commercial production of PGPR, their delivery systems, and monitoring
29. Biological control in IDM
30. IPM and organic farming system
31. IPM and organic farming system
32. Biopesticides available in market
33. Biopesticides available in market
34. Quality control system of biocontrol agents

## **Practical Schedule**

Advanced methodology for Isolation, characterization (cultural, biochemical and molecular) and maintenance of antagonists, methods of study of antagonism and antibiosis, mass production of antagonists, application of antagonists against pathogen *in vitro* and *in vivo* conditions.

1. Isolation of fungal antagonists
2. Isolation of bacterial antagonists
3. Isolation of PGPR
4. Testing the antagonistic efficacy
5. Testing plant growth promotion activity
6. Cultural and molecular characterization of fungal antagonists
7. Biochemical and molecular characterization of bacterial antagonists
8. Biochemical and molecular characterization of PGPR
9. Methods of study of antagonism
10. study of antagonism and ISR
11. Maintenance of antagonists
12. Mass production of fungal antagonists
13. Mass production of bacterial antagonists and PGPR
14. Formulations and Quality control
15. Evaluation of antagonists against pathogen under *in vitro* conditions
16. Evaluation of antagonists against pathogen under *in vivo* condition
17. Visit to commercial biocontrol agent production unit.

## **Course Outcome**

- CO 1.** Having updated knowledge of new bio regulators.
- CO 2.** Having knowledge about the factors influence the bio-agents
- CO 3.** Having knowledge, the Hypovirulence, suppressive soil and compatibility of Bio control agents.
- CO 4.** Trained in mass production and quality control methods of Bio control agents.
- CO 5.** Expertise in commercial formulation and delivery system of biocontrol agent

## CO – PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	0	1	0	1
CO 2	1	0	2	0	3	0
CO 3	1	2	1	0	1	1
CO 4	1	0	1	0	0	3
CO 5	1	0	0	1	0	3

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2. Cook RJ and Baker KF (1983). *Nature and Practice of Biological Control of Plant Pathogens*. APS, St. Paul, Mennisota.
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5. Heikki MT and Hokkanen James M (Eds.) (1996). *Biological Control - Benefits and Risks*. Cambridge Univ. Press, Cambridge.
6. Mukerji KG, Tewari JP, Arora DK and Saxena G (1992). *Recent Developments in Biocontrol of Plant Diseases*. Aditya Books, New Delhi.

## PAT 825 MUSHROOM TECHNOLOGY (2+1)

### Learning Objectives

- To provide detail knowledge about the economically important edible fungi (mushrooms).
- To provide detail knowledge about the important cultivated mushrooms from Ascomycets and Basidiomycets.
- To provide detail knowledge about the mushroom biotechnology.
- To provide detail knowledge about the recent advances in cultivation of edible mushroom.
- To provide recent knowledge about the small- and large-scale production.

## **Theory**

### **Unit – I Introductory mushroom**

Mushroom - History, Development of commercial cultivation, present status. Economic importance and medicinal value. Taxonomy and classification of mushroom fungi. Edible and poisonous mushrooms.

### **Unit – II Mushroom culture and spawn production**

Reproduction and Life cycle of cultivated mushrooms. Maintenance of pure culture and strain improvement. Spawn production and establishment of commercial spawn production laboratory.

### **Unit – III Substrate for mushroom cultivation**

Preparation of substrate for mushroom cultivation. Composting of substrate - long, short and indoor methods, formulae of different composts and computation thereof - qualities and testing of compost. Uses of spent mushroom compost and substrate. Hazards risks associated with composting and its management.

### **Unit – IV Mushroom cultivation technology**

Mushroom Farm – Establishment, seasonal and environmental control for commercial cultivation, Ventilation and CO<sub>2</sub>, Maintenance of Temperature and RH. Selection of commercially important mushroom *Agaricus bisporus*, *Pleurotus* spp., *Volvariella* spp. *Calocybe indica*, *Lentinus edodes*, *Auricularia* sp. and *Ganoderma lucidum*. Insect pests, diseases and abnormalities of cultivated mushroom and their management.

### **Unit – V Economics of mushroom cultivation**

Economics and Extension in mushroom cultivation. Post-harvest handling of edible mushrooms and value addition in mushrooms. Biotechnology and mushroom cultivation.

## **Lecture schedule**

1. Current overview of mushroom production in the world
2. World mushroom industry
3. Cultivated mushroom production in the world
4. World edible mushroom production
5. Contribution of different mushrooms in Indian production
6. Economic importance and medicinal value
7. Taxonomy and classification of mushroom fungi

8. Edible and poisonous mushrooms
9. Reproduction and life cycle of cultivated mushrooms
10. Maintenance of pure culture and strain improvement
11. Spawn production
12. Spawn production
13. Establishment of commercial spawn production laboratory
14. Preparation of substrate for mushroom cultivation
15. Composting of substrate - long and short methods
16. Composting of substrate - indoor methods
17. Formulae of different composts and computation thereof qualities and testing of compost
18. Uses of spent mushroom compost and substrate
19. Mid-semester examination
20. Mushroom farm – establishment
21. Mushroom farm – seasonal and environmental control for commercial cultivation, ventilation and CO<sub>2</sub>, maintenance of temperature and RH.
22. Commercial cultivation technology of *Agaricus bisporus*
23. Commercial cultivation technology of *Pleurotus* spp.
24. Commercial cultivation technology of *Volvariella* spp.
25. Commercial cultivation technology of *Calocybe indica*
26. Commercial cultivation technology of *Lentinus edodes*
27. Commercial cultivation technology of *Auricularia* sp.
28. Commercial cultivation technology of *Ganoderma lucidum*
29. Insect pests of cultivated mushroom and their management
30. Diseases and abnormalities of cultivated mushroom and their management
31. Post-harvest handling of edible mushrooms
32. Value addition in mushrooms
33. Biotechnology and mushroom cultivation
34. Economics and extension in mushroom cultivation

### **Practical**

Introduction to edible and poisonous mushroom, Sterilization techniques, Preparation of culture media, Isolation of mushroom culture (Pure culture technique), Identification of mushroom culture – microscope level – molecular level, Preservation of mushroom

cultures – short term – long term, Type of spawn, spawn production, multiplication of spawn, Mushroom cultivation techniques *Agaricus bisporus*, *Pleurotus* spp., *Volvariella* spp., *Calocybe indica*, *Lentinus edodes*, *Auricularia* sp. and *Ganoderma lucidum*, Insect pests, diseases and abnormalities of cultivated mushroom and their management, Post-harvest technology, Establishment of commercial spawn and mushroom production laboratory.

### **Practical schedule**

1. Introduction to edible and poisonous mushroom
2. Sterilization techniques
3. Preparation of culture media
4. Isolation of mushroom culture (Pure culture technique)
5. Identification of mushroom culture – microscope level – molecular level
6. Preservation of mushroom cultures – short term – long term
7. Type of spawn, spawn production, multiplication of spawn
8. Mushroom cultivation techniques *Agaricus bisporus*
9. Mushroom cultivation techniques *Pleurotus* spp.
10. Mushroom cultivation techniques *Volvariella* spp.
11. Mushroom cultivation techniques *Calocybe indica*
12. Mushroom cultivation techniques *Lentinus edodes*
13. Mushroom cultivation techniques *Auricularia* sp.
14. Mushroom cultivation techniques *Ganoderma lucidum*
15. Insect pests, diseases and abnormalities of cultivated mushroom and their management
16. Post-harvest technology
17. Establishment of commercial spawn and mushroom production laboratory

### **Reference books**

1. Chang ST and Hayes WA (1978). *The biology and cultivation of edible mushrooms*. Academic Press,
2. Diego Cunha Zied and Arturo Pardo-Giménez (2017). *Edible and Medicinal Mushrooms: Technology and Applications*. John Wiley & Sons Ltd.
3. Gogoi R, Rathaiah, Y and Borah TR (2006). *Mushroom Cultivation Technology*. Scientific Publishers.
4. Kapoor JN (2016). *Mushroom Cultivation*. ICAR Publication.

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### **Journals**

Indian Journal of Mushrooms

International Journal of Medicinal Mushrooms

Medicinal Mushrooms

Mushroom Journal

Mushroom Research

Mushroom Science

Mushroom: The Journal of Wild Mushrooming

### **Course Outcome**

CO 1 Generate knowledge about the mushrooms

CO 2 Mushroom biology

CO 3 Cultivation techniques

CO 4 The researchers for conducting individual research on mushroom

CO 5 Entrepreneur development

	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>
<b>CO 1</b>	3	0	0	0	0	3
<b>CO 2</b>	3	0	0	0	0	3
<b>CO 3</b>	3	0	0	0	0	3
<b>CO 4</b>	3	0	0	0	0	3
<b>CO 5</b>	3	0	0	0	0	3

## **SUPPORTING COURSES**

### **COM 811 ADVANCES IN COMPUTING APPLICATIONS (0+1)**

#### **Learning Objectives**

1. To understand the concepts of computer, to get knowledge in office like MS Word , MS Excel, SPSS, Html and Multimedia Applications.
2. To make them acquire sound knowledge in various Agricultural statistical software and their analysis.
3. To improve knowledge to get exposed to the current trends in Internet and their usage.

#### **Practical Schedule:**

1. Ms word –Creating a Mail Merge and Label
2. Ms Excel -Statistical Function and Data Analysis
3. Mean, Median, Variance, Standard Deviation, Correlation, Histogram
4. Ms-Access –Database Creation
5. Query Execution and Report generation
6. Multimedia Applications
7. Text Animating
8. Morphing
9. Creation of Webpage
10. Webpage creation using basic HTML tags ,Hyperlink and Images
11. Introduction to Artificial Intelligence in Agriculture
12. Statistical Analysis using SPSS
13. Factor analysis
14. Cluster analysis
15. Discriminant analysis
16. Multidimensional scaling
17. Exposure to Internet and research analysis

#### **COURSE OUTCOME**

1. Performing common basic functions like editing, formatting, printing, scanning etc using tools.
2. Create and populate a Ms-Access for a real life application, with constraints and keys, using SQL.
3. Able to describe and appreciate the applications of multimedia and identify different types of multimedia elements.
4. Understand how to start SPSS
5. Define a variety of statistical variables and enter basic data into SPSS



## PO-CO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO5	PO6
CO 1	3	2	2	0	3	3
CO 2	3	0	2	1	3	3
CO 3	3	1	2	0	3	3
CO 4	3	2	0	2	3	2
CO 5	3	2	1	2	3	3

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1. Kathy Jacobs. 2007. Microsoft Office Excel, The L line The Express line to Learning, Wiley, India Publications.
2. TNAU.2004. Advanced Quantitative Techniques and Data Analysis “Training Manual – Agrl. Engineering College and Research Institute, Coimbatore.
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4. Thomas Powell. 2010. HTML and CSS The Complete Reference, Fifth Edition, Tata Mc Graw Hill Publishing Company Limited, New Delhi.
5. <http://en.wikipedia.org/wiki/Internet>.

## LIS 812 ADVANCES IN AGRICULTURAL INFORMATION RETRIEVAL (0+1)

### LEARNING OBJECTIVE

- Students will acquire knowledge on importance of information centers for agricultural research
- To obtain awareness on KVK library in Information Transfer Process
- To equip knowledge on Institutional Repository of Indian National Agricultural Research System
- To gain familiarity on Consortium for e-Resources in Agriculture (CeRA)
- To develop knowledge and skills an agricultural databases

### PRACTICAL

Information centers for agriculture development; Agricultural information services, Search engines, Library websites – Institutional Repository

Digital Libraries for agricultural development - Role of KVK library in Information Transfer Process - Library Consortium- Information Library Network (INFLIBNET); National Institute of Science Communication and Information Resources (NISCAIR)

Web of Science; Impact Factor- Scopus - H index; Indian Council of Agricultural Research (ICAR), Krishkosh - An Institutional Repository of Indian National Agricultural Research System, **AGRICultural OnLine Access (AGRICOLA)**, Access to Global Online Research in Agriculture (AGORA), Consortium for e-Resources in Agriculture (CeRA), Centre for Agriculture and Bioscience International (CABI); e-resources access search methods.

## **PRACTICAL SCHEDULE**

1. Information center for agriculture development
2. Agricultural information services
3. Search engines, Library websites
4. Institutional Repository
5. Digital Libraries for agricultural development
6. Role of KVK library in Information Transfer Process
7. Library Consortium
8. Directory of open access journals (ODAJ)
- 9 Mid- Semester**
10. INFLIBNET
11. National Institute of Science Communication and Information Resources (NISCAIR)
12. Web of Science - Impact factor
13. Scopus - H index
14. Indian Council of Agricultural Research (ICAR)
15. Institutional Repository of Indian National Agricultural Research System (Krishkosh)
16. AGRICultural OnLine Access (AGRICOLA)
17. Access to Global Online Research in Agriculture (AGORA)
18. Consortium for e-Resources in Agriculture (CeRA), CABI

## **COURSE OUTCOMES:**

- CO 1:** The course outcome will acquire knowledge on importance of information centers for agricultural research
- CO 2:** The course outcome will augment the knowledge on KVK library in Information Transfer Process
- CO 3:** The course outcome will able to Institutional Repository of Indian National Agricultural Research System
- CO 4:** The course outcomes will familiarity on Consortium for e-Resources in Agriculture (CeRA)
- CO 5:** The course outcome will fortify the students to develop knowledge and skills and agricultural database

## CO-PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO5	PO6
CO 1	3	1	2	1	3	2
CO 2	3	0	2	0	3	2
CO 3	3	1	2	1	3	2
CO 4	3	2	1	0	3	2
CO 5	3	0	1	0	3	3

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2. Burnett, Robert and Marshall P David. 2003; Web theory: An introduction. London: Routledge.
3. Cheung. A home on the web: Presentations of self on personal homepages. (In:Guantlett, D: Web studies : Rewiring media studies for the digital age. London: Arnold 2000)
4. Herman and Swiss T, eds. The World Wide Web and contemporary cultural theory. New York. Routledge, 2000
5. Jones S G. ed. Virtual culture: Identity and communication in cyber society. London. Sage publications, 1997

### Websites

1. <https://doaj.org/>
2. <http://www.niscair.res.in/>
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4. <http://krishikosh.egranth.ac.in/>
5. <https://library.udel.edu/databases/agricola/>
6. <http://cera.iari.res.in>

## STA 821 ADVANCES IN DESIGN OF EXPERIMENTS (2+1)

### LEARNING OBJECTIVES

- The students will acquire sufficient basics of Statistical methods.
- To help them in understanding the concepts involved in data collection, presentation analysis and interpretation of results.
- To enhance the knowledge of students pertaining to testing Statistical Hypothesis.
- To acquire Multivariate Statistical Analysis skills.
- The students would be exposed to concepts of design of experiments.

## **THEORY**

### **Unit-I: Sampling Techniques**

Concept of sampling: Sampling vs complete enumeration. Planning of sample survey. Sampling from a finite population. Simple random sampling. Inverse sampling. Stratified sampling. Cluster sampling. Systematic sampling. Multistage sampling. Double sampling. Ratio and regression method of estimation. Non-sampling errors. Concept and levels of measurement. Non-parametric tests - Sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal-Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

### **Unit-II: Statistical Methods**

Classification, tabulation and graphical representation of data. Descriptive statistics. Theory of probability. Random variable and mathematical expectation. Box-plot. Probability distributions: Binomial, Poisson, Negative binomial, Normal distributions and their applications. Concept of sampling distribution: t, chi-square and F distributions. Tests of significance based on normal, t, chi-square and F distributions.

### **Unit-III: Correlation and Regression Analysis**

Correlation, Rank correlation, Correlation ratio, Intra-class correlation. Test of significance of correlation coefficient. Coefficient of determination.- Path analysis - Regression analysis, Partial and multiple correlation and regression. Estimation of parameters. Predicted values and residuals. Introduction to multivariate analytical tools. Test of hypothesis on means, Multivariate analysis of variance and covariance, Cluster analysis, Classification by linear discriminant function, Canonical correlations, Principal components, Factor analysis, multi-dimensional scaling and Correspondence Analysis. Hierarchical clustering. Principal component analysis.

### **Unit-IV: Experimental Designs**

Need for design of experiments, characteristics of a good design. Basic principles of designs - randomization, replication and local control. Uniformity trials, size and shape of plots and blocks; Analysis of variance and covariance; partitioning of degrees of freedom - Completely randomized design, randomized block design and Latin square design.

## **Unit-V: Factorial Experiments**

Factorial experiments : Layout and analysis of factorial experiments – complete block design – split – plot design : strip-plot design : split split – plot design. Resolvable block designs and their applications. Randomization procedure, analysis and interpretation of results. Analysis of covariance. Missing plot technique and its application to RBD, LSD. Factorial experiments (symmetrical as well as asymmetrical). Factorial experiments with control treatment. Groups of experiments. Transformation of data.

### **PRACTICAL**

Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests, Testing of hypothesis based on exact sampling distributions ~ chi square, t and F. Confidence interval. Estimation and point estimation of parameters of Binomial, Poisson and Normal distribution. Correlation and regression analysis. Fitting of orthogonal polynomial regression. Applications of dimensionality reduction and Discriminant function analysis. Non-parametric tests. Analysis of data obtained from CRD, RBD, LSD. Analysis of Covariance, Analysis of factorial experiments without and with confounding, Analysis with missing data. Split plot and strip plot designs. Groups of experiments, Transformation of data. Exercises on various Non-parametric tests; Random sampling, Use of random number tables, Simple random sampling, Determination of sample size, Exercises on Inverse sampling, Stratified sampling, Cluster sampling and Systematic sampling, Estimation using Ratio and regression estimators, Estimation using Multistage design and Double sampling.

### **THEORY LECTURE SCHEDULE**

1. Classification, tabulation and graphical representation of data.
2. Descriptive statistics.
3. Theory of probability. Random variable and mathematical expectation.
4. Box-plot. Probability distributions: Binomial, Poisson, Negative binomial.
5. Normal distributions and their applications.
6. Concept of sampling distribution: t, chi-square and F distributions.
7. Tests of significance based on normal, t, chi-square and F distributions.
8. Correlation, Rank correlation, Correlation ratio.
9. Intra-class correlation. Test of significance of correlation coefficient.
10. Coefficient of determination.

11. Path analysis.
12. Regression analysis.
13. Partial and multiple correlation and regression.
14. Estimation of parameters. Predicted values and residuals.
15. Introduction to multivariate analytical tools.
16. Test of hypothesis on means, Multivariate analysis of variance and covariance.
17. Cluster analysis, Classification by linear discriminant function.
18. Canonical correlations, Principal components.
19. Factor analysis, multi- dimensional scaling and Correspondence Analysis.
20. Hierarchical clustering.
21. Principal component analysis.
22. Need for design of experiments, characteristics of a good design.
23. Basic principles of designs - randomization, replication and local control.
24. Uniformity trials, size and shape of plots and blocks; Analysis of variance and covariance; partitioning of degrees of freedom.
25. Completely randomized design, randomized block design and Latin square design.
26. Factorial experiments : Layout and analysis of factorial experiments.
27. Complete block design – split – plot design.
28. Strip-plot design : split split –plot design.
29. Resolvable block designs and their applications.
30. Randomization procedure, analysis and interpretation of results.
31. Analysis of covariance. Missing plot technique and its application to RBD, LSD.
32. Factorial experiments (symmetrical as well as asymmetrical).
33. Factorial experiments with control treatment.
34. Groups of experiments. Transformation of data.

### **PRACTICAL SCHEDULE**

1. Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests.
2. Testing of hypothesis based on exact sampling distributions ~ chi square, t and F. Confidence interval.
3. Estimation and point estimation of parameters of Binomial, Poisson and Normal distribution.
4. Correlation and regression analysis.
5. Fitting of orthogonal polynomial regression.
6. Applications of dimensionality reduction and Discriminant function analysis. Non-parametric tests.

7. Analysis of data obtained from CRD, RBD, LSD.
8. Analysis of Covariance.
9. Analysis of factorial experiments without and with confounding, Analysis with missing data.
10. Split plot and strip plot designs. Groups of experiments, Transformation of data.
11. Exercises on various Non-parametric tests.
12. Random sampling, Use of random number tables, Simple random sampling, Determination of sample size.
13. Exercises on Inverse sampling, Stratified sampling.
14. Cluster sampling and Systematic sampling.
15. Estimation using Ratio and regression estimators.
16. Estimation using Multistage design and Double sampling.
17. Practical Examination.

### **Course Outcome**

- CO 1: The course outcome will reveal the knowledge of basic statistical methods.
- CO 2: The course outcome will ensure the understanding the concept involved in Data Collection, Presentation, Analysis and Interpretation of results of Agricultural Sciences.
- CO 3: The course outcome will support the students to do in testing of Statistical Hypothesis.
- CO 4: The course outcome will convey the knowledge of students to do Multivariate Statistical Analysis.
- CO 5: The course outcome will assist the students to design their experiments in Agricultural field and collect the experimental data for analysis.

### **PO-CO-Mapping Matrix**

	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO 1</b>	3	1	1	1	3	1
<b>CO 2</b>	3	1	1	1	3	1
<b>CO 3</b>	3	1	1	2	3	2
<b>CO 4</b>	3	2	1	1	3	2
<b>CO 5</b>	3	1	1	1	3	2

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