



ANNAMALAI UNIVERSITY

(Accredited with 'A' Grade by NAAC)

FACULTY OF AGRICULTURE

(Accredited by ICAR)



DEPARTMENT OF ENTOMOLOGY

Academic Regulations and Syllabi

**MASTER OF SCIENCE IN
AGRICULTURAL ENTOMOLOGY
(Semesters 1- 4)**

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

2018-2019 Onwards (Revised)

ANNAMALAI UNIVERSITY
FACULTY OF AGRICULTURE
ACADEMIC REGULATIONS
GENT21 M.Sc.(Ag.) AGRICULTURAL ENTOMOLOGY
(With effect from 2018-2019)

1. Short title and commencement

1.1. These rules and regulations shall govern the post graduate study leading to the award of degree of Master of Science (Agriculture) Agricultural Entomology in the Faculty of Agriculture.

1.2. They shall come into force with effect from the academic year 2019 – 2020 onwards.

2. Definitions

2.1. An “Academic Year” shall consist of two semesters.

2.2. “Semester” means an academic term consisting of 110 working days including mid semester, practical and 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 laboratory/field practical per week in a semester.

2.5. “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.

2.6. “Credit Point” means the grade point multiplied by credit hours.

2.7. “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 point scale and the GPA has to be corrected to two decimals.

2.8. “Overall Grade Point Average” (OGPA)/“Cumulative Grade Point Average” (CGPA) 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 courses which he/she had completed up to the end of a specified semester and determines the overall performance of a student in all courses during the period covering more than one semester. The OGPA has to be arrived at the second decimal place.

3. Eligibility for admission

3.1. Candidates seeking admission to the M.Sc.(Ag.) Agricultural Entomology programme should have completed any one of the following four year degree programmes from Universities recognized by Annamalai University. B.Sc. (Hons.) Agriculture/B.Sc. (Hons.) Horticulture/B.Sc.(Ag.)/B.Sc.(Hort.)/B.Tech.(Hort.)/B.Sc.(Forestry)/B.Tech.(Agri. Bio-tech.) courses of four years duration of a recognized university.

3.2. Candidates who have undergone the programme under conventional system should possess not less than a second class Bachelor’s degree. The candidates under 4 point grade systems should possess a minimum OGPA of 2.5 out of 4.00 and 2.75 out of 4.00 in the course concerned. For those in the 10 point system a minimum OGPA of 6.00 out of 10.00 and 6.50 out of 10.00 in the course concerned is required. However, this will not apply to SC/ST candidates for whom a pass in the degree concerned is sufficient.

3.3. An entrance test will be held separately for each Degree programme. Candidates shall be required to be present on the specified date and time for written test and interview at their own expenses.

4. Award of Degree, duration and credit requirements

A student is required to complete the duration and credit requirements for the award of degree as decided by Academic Council from time to time.

4.1. The duration for the M.Sc. (Ag.) Agricultural Entomology programme will be of two years with four semesters. A student registered for Full- time M.Sc.(Ag) Agricultural Entomology programme should complete the course within four years from the date of his/her admission.

4.2. A student enrolled for the M.Sc. (Ag.) Agricultural Entomology programme to earn eligibility for the degree is required to complete 55 credits as detailed below.

S.No.	Course	Credit requirements
i	Major Courses	20
ii	Minor Courses*	9
iii	Supporting Courses	5
iv	Seminar	1
v	Research	20
	Total	55

***Minor courses:** Minor courses are to be chosen by the students from the related disciplines in consultation with the Head of the Department and the Chairperson based on their research specialization.

5. Minimum Grade point requirement

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

6. Attendance requirement

6.1. One hundred per cent attendance is expected of each student. A student, who fails to secure a minimum of 80 per cent of attendance in each course separately for theory and practical, shall not be permitted to appear for the final examination in that course and will be required to repeat the course when ever offered. In case of new admission, who are permitted to join late due to administrative reasons, the attendance will be calculated from the date of joining of the student. However, for genuine reasons, condonation of attendance deficiency may be considered by the Vice-Chancellor on the recommendation of the Head of the Department and the Dean, Faculty of Agriculture on payment of condonation fee prescribed by the University.

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

7. Advisory Committee

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

Faculty of Agriculture. The Advisory Committee shall be constituted within three weeks from the date of commencement of the first semester.

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

7.3. Major Adviser (Chairman)

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

7.4. Guidelines on the duties of the Advisory Committee

1. Guiding students in drawing the outline of research work
2. Guidance throughout the programme of study of the students.
3. Evaluation of research and seminar credits.
4. Correction and finalization of thesis draft.
5. Conduct of qualifying and final Viva-Voce examination.
6. The proceedings of the Advisory Committee will be sent to the Head of the Department concerned within 10 working days.
7. Periodical review of the Advisory Committee proceedings will be made by the Head of the Department concerned.

8. Programme of Study

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

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

8.3. Programme of research work

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

9. Evaluation of students' performance

9.1. Mid-semester examination (MSE)

- 9.1.1. Every teacher handling a course shall conduct Mid-Semester Examination (MSE) as per the scheme drawn by the Head of the Department concerned /PG coordinator, and evaluate. The answer scripts will be shown to the student after valuation, and returned to the course teacher. The Head of the Department will be responsible to ensure the distribution of answer papers to the students. The marks obtained by the students should be sent to the Controller of Examinations through the Head of the Department concerned within fifteen working days.

- 9.1.2. Writing the mid-semester examination is a pre-requisite for writing the final theory and practical examinations. If a student does not appear for MSE, he/she is not eligible to appear for the final examinations. Such candidate has to reappear for the MSE as and when the respective examinations are conducted only after getting permission from the Dean, Faculty of Agriculture on payment of fee prescribed by the University.
- 9.1.3. The MSE marks will not be shown separately in the grade sheet but will be combined with the respective final theory and practical marks. MSE marks awarded in a course will be added to the supplementary examinations also.
- 9.1.4. The MSE marks will be furnished to the Head of the Department within 10 days after the conduct of MSE. If the student is not satisfied with the award of the marks, he/she shall appeal to the Dean, through the Head of the Department within three working days after the announcement of marks. The appeal will be considered and the results reviewed by a Cell consisting of the Dean and the Head of the Department concerned. The decision of the Review Cell shall be final. If the Head of the Department himself is the course teacher, one senior member of the Department concerned shall be nominated by the Dean.
- 9.1.5. The MSE of theory will be of one hour duration
- 9.1.6. If the student is not able to write the MSE due to deputation by the University, he/she may be permitted to take up missing MSE. Such examination should be completed ordinarily within 15 working days after the respective MSE.
- 9.1.7. A student who fails to attend the a mid-semester examination due to unavoidable circumstances shall be permitted with prior approval of the Dean to take up missing examination of the particular course, on payment of fee prescribed by the University. Such tests should be completed ordinarily within 15 working days after the respective MSE. The distribution of marks will be as indicated below.

Examination	Courses with Practical	Courses without Practical	Courses without Theory
Mid-semester	20	30	30
Final theory	40	70	-
Final practical	40	-	70
Total	100	100	100

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

Mid-semester examination

For Courses with practical (20 marks)

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	2 out of 3	(2 X 2 ½)	5 Marks
4. Essay Type	1 out of 2	(1 X 5)	5 Marks

For Courses without practical (30 marks)

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

9.2. Final examinations

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

9.2.2. Theory examinations will be conducted before practical examinations.

9.2.3. The final theory and practical examinations will be evaluated by two examiners (one will be the course teacher and the other will be one among the senior faculty suggested by the Head of the Department in consultation with the The Dean, Faculty of Agriculture)

9.2.4. The question papers for the final theory examinations will be set by the person selected from the approved panel of question paper setters.

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

Final theory examination

For courses with practical (40 marks)

1. Definitions	5 out of 7	(5X1)	5 Marks
2. Short Notes	5 out of 7	(5X2)	10 Marks
3. Essay Type	Either or type (one question from each unit)	(5X5)	25 Marks

For courses without practical (70 marks)

1. Definitions	5 out of 7	(5X2)	10 Marks
2. Short Notes	5 out of 7	(5X4)	20 Marks
3. Essay Type	Either or type (one question from each unit)	(5X8)	40 Marks

9.2.5. Practical Examination

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

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

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

9.3. Grading

The student should secure 60 per cent marks separately in theory and practical and 65 per cent marks in aggregate to secure a pass in the course. Students who secure marks below 65 per cent in a course will be treated as Reappearance (RA).

Each course shall carry a maximum of 100 marks for purpose of grading. The grading shall be done as grade point, i.e., the percentage of marks earned in a course is divided by ten. The grade point is expressed on a 10 point scale up to two decimals.

The reappearance examinations for the candidates who fail in a course or courses will be held in the subsequent semester.

Students who did not fulfil the required minimum attendance of **80 per cent** will be awarded 'E' grade and has to repeat the course.

9.4. Class ranking

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

OGPA	Class
9.00 and above	Distinction
8.00 to 8.99	I Class
7.00 to 7.99	II Class
6.50 to 6.99	Pass

9.5. Non-Credit Compulsory Courses

For Non-Credit Compulsory courses the evaluation processes will be as that of the regular courses, however, the marks obtained will not be taken into account to calculate the OGPA.

10. Credit Seminar

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

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

The seminar topics are to be assigned to the students by the Chairman of the Advisory Committee in consultation with the Head of the Department concerned within 2 weeks after the commencement of the semester.

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

10.3. The circular on the seminars by the post-graduate students shall be sent to other Departments to enable those interested to attend the same.

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

The student will incorporate suggestions and carry out corrections made during the presentation and resubmit three fair copies to the Head of the Department concerned

through the Chairman (one copy each to Dept. Library, Chairman and the student) within 10 days after presentation.

- 10.5. The performance of the student has to be evaluated for 100 marks and Grade Point will be awarded by the Head of the Department concerned along with Advisory Committee. The Grade Point may be given based on the following norms.

Coverage of Literature	40
Presentation	30
Use of Audio-Visual Aids	10
Capacity to Participate in the discussion and answer the Questions	20
Total	100

11. Term paper / Special assignment

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

12. Qualifying Examination

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

12.1. Minimum requirement for Qualifying Examination

The students who have passed major courses will be permitted to appear for the qualifying examination. The qualifying examination will be conducted during III semester after mid-semester examination and before the end of the III semester.

12.2. Selection of Examiner

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

12.3. Written Examination

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

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

12.4. Qualifying viva-voce Examination

The Advisory Committee shall conduct the qualifying viva-voce examination with the external member, who shall be a specialist in the course from outside the University.

- 12.5. The Head of the Department will monitor and coordinate the conduct of the qualifying viva. The performance of the candidate will be graded as Satisfactory / Unsatisfactory.

12.6. Communication of results of qualifying examination

The Chairman of the Advisory Committee shall act as Chairman for the examination committee and shall be responsible for communicating the results of the examination to the Controller of Examinations through the Head of the Department in the prescribed format.

12.7. Failure /Absence in Qualifying Examination

When a student fails or absents himself/ herself for the qualifying examination, he/she may apply for permission to appear for re-examination to the Controller of Examinations with the recommendation of the Chairman of the Advisory Committee and the 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 Advisory Committee, Head of the Department and Dean, Faculty of Agriculture. If the student fails in the qualifying examination, the research credits registered in the III semester should not be evaluated unless he / she successfully completes the qualifying examination.

12.8. Absence of Advisory Committee member during qualifying/final viva-voce examination:

1. Conducting qualifying and final viva voce examination in the absence of Advisory Committee members is not allowed.
2. Under extra-ordinary circumstances if the qualifying/final viva-voce examination to postgraduate student has to be conducted in the absence of one or two advisory committee members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Dean in advance through the Head of the Department. The Chairman of the Advisory Committee in consultation with the concerned member and Head of the Department will co-opt another member.
3. The co-opted member should be from the same Department of the member who is not attending the examinations.
4. In the absence of the Chairman of Advisory Committee, respective Heads of Departments should act as Co-chairman with prior permission of Dean.

13. Research Work

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

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

I Semester	0+ 1
II Semester	0+ 2
III Semester	0+ 8
IV Semester	0+ 9
Total	0 + 20

14. Evaluation of Thesis Research

- 14.1. Attendance register must be maintained in the Department by Head of the Department/Chairman for all the students to monitor whether the student has 80% of attendance in research.
- 14.2. The student has to submit his/her research observation note book to the major Adviser. The major Adviser will scrutinize the progress and sign the note book with remarks as frequently as possible. This note book will form the basis for evaluation of research progress.
- 14.3. After completion of 80 per cent attendance for research and on or before the last day of the semester, the advisory committee should evaluate the progress of research work as per the approved programme and monitoring register and award **SATISFACTORY OR UNSATISFACTORY** depending upon quantity and quality of work done by the student during the semester.
- 14.4. The procedure of evaluating research credits under different situations is explained hereunder.

Situation - I	The student has completed the research credits as per the approved program and awarded ' SATISFACTORY ' by the Advisory Committee. Under the said situation the student can be permitted to register fresh credits in the subsequent semester. If the student is awarded ' UNSATISFACTORY ' he/she has to register afresh the same block of the research credits in the subsequent semester.
Situation - II	The student who does not satisfy the required 80 per cent attendance shall be awarded grade 'E'.
Situation-III	The student who could not complete the research work as per the approved programme of work for reasons beyond his/her control such as <ul style="list-style-type: none"> • Failure of crop • Non-Incidence of pests or diseases or lack of such experimental conditions • Non-availability of treatment materials like planting materials, chemicals etc. • Any other impeding/ unfavourable situation for satisfying the Advisory Committee • Under the situations (II & III) grade 'E' should be awarded. The student has to re-register the same block of research credits for which 'E' grade was awarded in the following semester. The student should not be allowed to register for fresh (first time) research credits. • In the mark sheet, it should be mentioned that 'E' grade was awarded due to lack of attendance or for want of favourable conditions.

Situation - IV	<p>The student who fails to complete the research work after repeating the registration for the second time will be awarded ' Unsatisfactory' and in the the mark sheet the 'second time' should be mentioned.</p> <ul style="list-style-type: none"> • For the registration of research credits for the third time permission has to be obtained from the Dean of the Faculty and permission for further registration for the fourth time has to be obtained from the University. • Re-registration of further research credits shall be decided by the University based on the recommendation of the Advisory Committee, Head of the Department concerned and the Dean, Faculty of Agriculture.
Situation-V	<p>If a student could not complete qualifying examination till the end of the final semester/grace period, 'E' grade should be awarded for the final block of the research credits registered in the final semester. He/She has to re-register the same block of research credits in the next semester and attend the qualifying examination when conducted by the Controller of Examinations.</p>

15. Submission of Thesis

- 15.1. The thesis for his/her Master's degree should be of such a nature as to indicate a student's potentialities for conduct of independent research. The thesis shall be on topic falling within the field of the major course and shall be the result of the student's own work. A certificate to this effect duly endorsed by the Major Adviser (Chairman) shall accompany the thesis.
- 15.2. The research credits registered in the last semester of post graduate programmes should be evaluated only at the time of the submission of thesis, by the Advisory Committee. Students can submit the thesis at the end of the final semester. If a post graduate student has completed the thesis before the closure of the final semester, the chairman can convene the Advisory Committee meeting and take decision on the submission of thesis provided the student satisfies 80 per cent attendance requirement. Two copies of the thesis should be submitted in paper back for evaluation to the Head of the Department.

16. Grace period

- 16.1. Students can avail a grace period up to a month for submission of thesis/project report after the closure of final semester by paying necessary fine as prescribed by the University. If a student is not able to submit the thesis within a month's grace period, the student has to re-register the credits in the forth coming semester. The student (s) who re-register the credits after availing the grace period will not be permitted to avail grace period.
- 16.2. Based on the recommendation of Advisory Committee and the Head of the Department, the Dean, can sanction the grace period. A copy of the permission letter along with the receipt for payment of fine as prescribed by the University should accompany the thesis while at the time of submission.

17. Submission of thesis after re-registration

The minimum of 80 per cent attendance requirement for submitting the thesis after, re-registration need not be insisted for those students who have fulfilled the minimum academic and residential requirement i.e. 2 years (4 semesters) and completed the minimum credit requirements for getting the Degree.

18. Publication of articles

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

19. Evaluation of Thesis

- 19.1. The thesis submitted in partial fulfilment of a Master's degree shall be evaluated by an external examiner. The external examiner shall be a specialist in the student's major field of study from outside Annamalai University and shall be appointed by the University as per the recommendation of the Head of the Department.
- 19.2. The external examiner will send the evaluation report in duplicate one marked to the Controller of Examinations and another to the Head of the Department along with the corrected copy of the thesis. If the report is favourable, Viva-Voce will be arranged by the Head of the Department concerned and conducted by the Advisory Committee. The Chairman of the Advisory Committee shall send the recommendations of the examining committee to the Controller of Examinations through the Head of the Department after the student duly carries out the corrections/ suggestions mentioned by the external examiner (a certificate to be enclosed along with the recommendation). On the unanimous recommendation of the committee and with the approval of the University, the degree shall be awarded to the candidate.
- 19.3. In case of rejection of the thesis by the external examiner, the Controller of Examinations may on the recommendation of the Head of the Department concerned and Advisory Committee refer the thesis for valuation by a second external examiner chosen by the University. If the second external examiner recommends the thesis for acceptance, Viva-Voce will be conducted.
- 19.4. If the revision of the thesis is recommended for repeating experiments, field trial etc., resubmission must be done by the candidate concerned after a minimum of six months. The revised version should be sent to the examiner who recommended revision.
- 19.5. After incorporating the suggestions of the examiners and those received at the time of viva-voce, two hard bound copies of thesis should be submitted to the Department (one to the scholar and one to the Chairperson) and two soft copies in CDs to the University. At the time of final submission, the advisory committee members should certify the corrections and suggestions carried out as indicated by the examiners. However, fellowship holder have to submit a hard bound copy also as per the need, 3 copies of abstract of thesis (in 10-15 lines), 2 copies of the summary of the findings both in Tamil and English and also in CD form.

20. Revision of thesis

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

- 20.1. For revision of draft, the thesis should be resubmitted after a minimum of one month from the date of communication from the Controller of Examinations.
- 20.2. At the time of re-submission, necessary certificate is to be obtained from the Chairman and Head of the Department before the conduct of the final viva-voce indicating that the corrections specified by the external examiner have been carried out.
- 20.3. A fine prescribed by the University to be collected from the students at the time of resubmission of thesis.

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

- 21.1. If a candidate fails to appear before the examining committee for final viva-voce, on the date fixed by the Head of the Department the following are the time frame and penalty.
- 21.2. The re-viva-voce must be completed within two years. The fine prescribed by the University must be paid by candidate.
- 21.3. After successful completion of thesis final viva-voce if a student fails to submit the corrected version of the thesis within 15 days he/she will be levied a fine prescribed by the University at the time of sending the proposal for result declaration

22. Result notification

- 22.1. After the completion of each semester, the student will be given the statement of marks by the Controller of Examinations
- 22.2. The transcript will be prepared by Controller of Examinations. Various courses taken by a student along with the credits and the grade obtained shall be shown on his/her transcript. Based on the total credits admitted, the final Grade Point Average shall be calculated and given.

23. Award of Medals

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

PROGRAMME OUTCOMES (PO)**GENT21 M.Sc. (Ag.) AGRICULTURAL ENTOMOLOGY**

1. Graduate will acquire comprehensive knowledge on basic concepts and current developments in insect morphology, classification, physiology, biocontrol, host plant resistance and toxicology. Understand the evolutionary and ecological relationships of insects with other life forms and the impact of insects relative to human health and well being and animal and plant health.
2. Graduates will be mastering in running taxonomy keys, dissecting insects, identifying symptoms of damage and pests and handling various basic and modern management techniques in plant protection.
3. Graduates will have expertise in handling complex technical, legal, societal and environmental issues in relation to bio-rational inputs and insecticide to address the dynamism in pest management.
4. Graduate will be able to develop skills on experimental tools in biological sciences, analytical techniques, statistical tools and analysis, research data computation.
5. Graduates will be able to identify the research gaps, design and execute individual research project, write concise and persuasive research articles and communicate effectively with their scientific colleagues, farmers and the general public. In addition to the expertise in the core field of specialization, graduates will be able to equip themselves in allied subjects of their choice to compliment their profession.

Abstract of Distribution Pattern of Courses and Credit

Semester	Number of Courses	Credit
I	8	9 + 6 = 15
II	8	9 + 7 = 16
III	6	4 + 11 = 15
IV	1	0 + 9 = 9
	Total credit	22+33 = 55

PO and Co Mapping Matrix

AFFINITY LEVELS	
1	Low
2	Moderate/ Medium
3	Substantial /High

DISTRIBUTION OF COURSES

Sl. No.	Course code	Course Title	Credit Hours
MAJOR COURSES			
1.	ENT 611	Insect Morphology and Classification	2+1
2.	ENT 612	Insect Anatomy, Physiology and Nutrition	2+1
3.	ENT 613	Insect Ecology, Pest Management, Storage and Quarantine Entomology	2+1
4.	ENT 621	Toxicology of Insecticides	2+1
5.	ENT 622	Biological Insect Pest Suppression	2+1
6.	ENT 623	Pests of Crops and their Management	2+1
7.	ENT 624	Plant Resistance To Pests	1+1
Total			13+7=20
MINOR COURSES			
1.	OPC GPB 621	Concepts of Crop Physiology	2+1
2.	OPC XXXXXX	Minor Course from other discipline	2+1
3.	OPC XXXXXX	Minor Course from other discipline	2+1
Total			6+3=09

SUPPORTING COURSES			
1.	STA 611	Statistical Methods and Design of Experiments	2+1
2.	COM 611	Computer Application For Agricultural Research	1+1
Total			3+2=05

SEMINAR AND RESEARCH			
1.	ENT 032	Seminar	0+1
2.	ENT 011, 021, 031, 041	Research 011- 0+1; 021 -0+2; 031 - 0+8; 041- 0+9	0+20
Total			0 + 21
Grand Total			22+33=55

NON CREDIT COMPULSORY COURSE			
1.	PGS 611	Agricultural Research Ethics and Methodology (Contact hour 0+1)	-
2.	PGS 612	Technical Writing And Communication Skills (Contact hour 0+1)	-
3.	PGS 623	Basic Concepts In Laboratory Techniques (Contact hour 0+1)	-
4.	PGS 624	Library and Information Services (Contact hour 0+1)	-
5.	PGS 715 (e-course)	Intellectual Property and Its Management in Agriculture (Contact hour 1+0)	-
6.	PGS 716 (e-course)	Disaster Management (Contact hour 1+0)	-
7.	PGS 717	Constitutions of India (Contact hour 1+0)	-

VALUE ADDED COURSES (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)

MINOR COURSES

S.No.	Course Code	Course Title	Credit	Departments Offering
1.	OPCAGR 711	Organic farming and precision agriculture	2+1	Agronomy
2.	OPCAGR 712	Dry farming and water shed management	2+1	Agronomy
3.	OPCENT 711	Productive insects and weed killers	2+1	Entomology
4.	OPCENT 712	Pest management in organic farming	2+1	Entomology
5.	OPCPAT 711	Biological control of crop diseases	2+1	Plant Pathology
6.	OPCPAT 712	Mushroom technology	2+1	Plant Pathology
7.	OPCAGM 711	Microbial inoculant production technology	2+1	Agricultural Microbiology
8.	OPCAGM 712	Industrial microbiology	2+1	Agricultural Microbiology
9.	OPCSSC 711	Soil, Water and air pollution	2+1	Soil science & Agrl. chemistry
10.	OPCSSC 712	Soil health management	2+1	Soil science & Agrl. Chemistry
11.	OPCABT 621	Concepts of crop physiology	2+1	Genetics & Plant Breeding
12.	OPC ABT 711	Bio-instrumentation	2+1	Genetics & Plant Breeding
13.	OPC ABT 712	Plant tissue culture	2+1	Genetics & Plant Breeding
14.	OPC GPB 711	Germplasm collection, exchange and quarantine	2+1	Genetics & Plant Breeding
15.	OPC GPB 712	Fundamentals of genetics	2+1	Genetics & Plant Breeding
16.	OPC SST 711	Seed production techniques in crops	2+1	Genetics & Plant Breeding
17.	OPC SST 712	Seed quality testing and certification	2+1	Genetics & Plant Breeding
18.	OPC HOR 711	Propagation and nursery management of horticultural crops	2+1	Horticulture
19.	OPC FSC 712	Genetic resources and conservation of fruit crops	2+1	Horticulture
20.	OPC VSC 712	Hi - tech vegetable production	2+1	Horticulture
21.	OPCFLA 712	Ornamental horticulture	2+1	Horticulture
22.	OPCPSM 712	Genetic resources and conservation of medicinal and aromatic plants	2+1	Horticulture
23.	OPC AEC 621	Natural resource and environmental economics	2+1	Agrl. Economics
24.	OPC AEC 711	Agribusiness analysis	2+1	Agrl. Economics
25.	OPC AEC 712	Agricultural insurance and risk management	2+1	Agrl. Economics
26.	OPCAEX 711	Farm journalism	2+1	Agrl. Extension
27.	OPCAEX 712	Introduction to visual communication and advertising technologies	2+1	Agrl. Extension

SEMESTER WISE DISTRIBUTION OF COURSES

I Semester			
Sl. No.	Course code	Course Title	Credit hours
1.	ENT 611	Insect Morphology and Classification	2+1
2.	ENT 612	Insect Anatomy, Physiology and Nutrition	2+1
3.	ENT 613	Insect Ecology, Pest Management, Storage and Quarantine Entomology	2+1
4.	STA 611	Statistical Methods and Design of Experiments	2+1
5.	COM 611	Computer Application for Agricultural Research	1+1
6.	ENT 011	Research	0+1
7.	PGS 611	Agricultural Research Ethics and Methodology (0+1)	-
8.	PGS 612	Technical Writing and Communication Skill (0+1)	-
Total			9 + 6=15
II Semester			
1.	ENT 621	Toxicology of Insecticides	2+1
2.	ENT 622	Biological Insect Pest Suppression	2+1
3.	ENT 623	Pests of Crops and their Management	2+1
4.	ENT 624	Plant Resistance to Pests	1+1
5.	OPCGPB 621	Concepts in crop physiology	2+1
6.	ENT 021	Research	0+2
7.	PGS 623	Basic Concepts In Laboratory Techniques (0+1)	-
8.	PGS 624	Library and Information Services (0+1)	-
Total			9+7=16
III Semester			
1	OPC-XXXXXX	Minor Course - Related discipline	2+1
2	OPC-XXXXXX	Minor Course - Related discipline	2+1
3.	ENT 031	Research	0+8
4	ENT 032	Seminar	0+1
5	PGS 715 (e-course)	Intellectual Property And Its Management In Agriculture (1+ 0)	-
6	PGS 716 (e-course)	Disaster Management (1+ 0)	-
7.	PGS 717#	Constitution of India (Contact hour 1+ 0)	
Total			4+11=15
IV Semester			
1.	ENT 041	Research	0+9
		Value Added Course (3+0)	-
Grand Total			22 + 33 = 55

(# - Instead of Value added course as per directions from the Higher Education dept. and approved in the Board of Studies held on 27.11.2019)

ENT 611 INSECT MORPHOLOGY AND CLASSIFICATION (2+1)

Learning objectives

- To understand the external morphology of insects
- To study the principles and concepts of insect classification
- To gain hands-on experience in diagnosing insect orders
- To gain hands on experience in preservation of insects
- To key out insect orders up to family level.

THEORY

UNIT I: Insect head and thorax

Tagmosis in insects -General body wall - its structure, cuticular outgrowths, special integumentary processes. Insect colouration. Body regions, sclerites, sutures and sulci. Insect head and its orientation; appendages of head and their modification- antenna and its modifications. Mouth parts in insects - mandibulate and haustellate types - their modifications - special types. Insect thorax and its appendages - Legs - modifications and types. Insect wings - development - venation - modifications and types - articulation with thoracic muscles.

UNIT II: Insect abdomen and metamorphosis

Insect abdomen - segmentation - modifications - appendages in different life stages - genitalia, their modification. Structure of sense organs. Insect metamorphosis - types of insect egg, larva and pupa.

UNIT III: Basics and advances in insect taxonomy

Insect taxonomy and systematics - definition and principles. Taxonomic publications, recent advances in insect taxonomy - micro and macro morphological, embryological, ecological, behavioural, cytological, biochemical and numerical taxonomy. Typological, nominalistic, biological and evolutionary species concepts. Taxonomic keys, International Code of Zoological Nomenclature (ICZN) - preamble - bi and trinomial nomenclature - major group names - validity of names - principle of priority, synonymy and homonymy, type concept.

UNIT IV: Classification of non-insect orders, apterygotes and exopterygotes

Recent classification of insects - Diagnosis of non-insect orders - Collembola, Protura and Diplura, Apterygotes -Archaeognatha and Zygentoma. Diagnosis of Palaeoptera and Neoptera. Diagnostic characters of orders and important families of Palaeoptera (Ephemeroptera and Odonata) and Neoptera - Plecoptera, Dermaptera, Embioptera, Zoraptera, Orthoptera, Phasmatodea, Grylloblattodea, Mantophasmatodea, Mantodea, Blattodea (roaches and termites), Psocodea (free-living and parasitic), Thysanoptera and Hemiptera.

UNIT V: Classification of endopterygotes

Diagnostic characters of various holometabolous insect orders and important families of Neuroptera, Megaloptera, Raphidioptera, Coleoptera, Strepsiptera, Diptera, Mecoptera, Siphonaptera, Trichoptera, Lepidoptera and Hymenoptera. **Current trends in morphology and taxonomy of Insects.**

PRACTICAL

Methods of collection and preservation of insects - External morphology of insects - detailed observation and naming of parts. Structure and modification of head, antennae and mouth

parts. Thoracic sclerites, structure and modification of legs, wings and their venation. Abdomen and its appendages. Genitalia of insects of representative orders and families. Morphological features of insect eggs, larvae, pupae and adults. Chaetotaxy in insects. Micrometry in insects, insect imaging and microphotography. Preparation of permanent slides. Study of insect orders and their identification using taxonomic keys. Observing and keying out orders and families of insects - Collembola, Protura, Diplura, Archaeognatha, Zygentoma, Ephemeroptera, Odonata, Plecoptera, Dermaptera, Embioptera, Orthoptera, Phasmatodea, Mantodea, Blattodea (roaches and termites), Psocodea (free-living and parasitic), Thysanoptera, Hemiptera, Neuroptera, Megaloptera, Raphidioptera, Coleoptera, Strepsiptera, Diptera, Mecoptera, Siphonaptera, Trichoptera, Lepidoptera and Hymenoptera. Field visit to agricultural, horticultural, forest and hill ecosystems to collect insects of different orders.

ASSIGNMENT - 10 permanent slides of appendages in insects - 5 immature stages (wet preservation) - Submission of fifty insects representing major families and orders.

THEORY LECTURE SCHEDULE

1. Introduction to morphology - Importance of insect morphology. Tagmosis in insects.
2. General body wall - its structure, cuticular outgrowths, special integumentary processes.
3. Insect colouration. Body regions, sclerites, sutures and sulci.
4. Insect head and its orientation; appendages of head and their modifications.
5. Mouth parts in insects - external structure - mandibulate types.
6. Mouth parts in insects - external structure - haustellate types.
7. Insect thorax and its appendages - Legs - modifications and types.
8. Insect wings - development - venation - modifications and types -articulation with thoracic muscles.
9. Insect abdomen - segmentation - modifications - appendages in different life stages.
10. Insect genitalia and their modification.
11. Structure of sense organs.
12. Insect metamorphosis - types of insect egg, larva and pupa - Sexual dimorphism polymorphism and polyphenism in insects.
13. Insect taxonomy and systematics - definition and principles.
14. Taxonomic publications, recent advances in insect taxonomy - micro and macro morphological, embryological, ecological, behavioural, cytological, biochemical and numerical taxonomy.
15. Typological, nominalistic, biological and evolutionary species concepts.
16. Taxonomic keys.
- 17. Mid Semester examination**
18. International Code of Zoological Nomenclature (ICZN) - preamble- bi and trinomial nomenclature.
19. Nomenclature - major group names- validity of names- principle of priority, synonymy and homonymy, type concept.
20. Recent classification of insects.

21. Diagnosis of non-insect orders – Collembola, Protura and Diplura.
22. Apterygotes –Archaeognatha and Zygentoma. Diagnosis of Palaeoptera and Neoptera.
23. Diagnostic characters of orders and important families of Palaeoptera (Ephemeroptera and Odonata).
24. Diagnostic characters of orders and important families of Neoptera – Plecoptera, Dermaptera, Embioptera and Zoraptera.
25. Diagnostic characters of orders and important families of Neoptera –Orthoptera.
26. Diagnostic characters of orders and important families of Neoptera - Phasmatodea, Grylloblattodea and Mantophasmatodea
27. Diagnostic characters of orders and important families of Neoptera - Mantodea, Blattodea (roaches and termites) and Psocodea (free-living and parasitic).
28. Diagnostic characters of orders and important families of Neoptera- Thysanoptera and Hemiptera.
29. Diagnostic characters and important families of orders Neuroptera, Megaloptera and Raphidioptera.
30. Diagnostic characters and important families of order Coleoptera.
31. Diagnostic characters and important families of orders Strepsiptera and Diptera.
32. Diagnostic characters and important families of orders Mecoptera, Siphonaptera and Trichoptera.
33. Diagnostic characters and important families of order Lepidoptera.
34. Diagnostic characters and important families of order Hymenoptera.

PRACTICAL SCHEDULE

1. External features of grasshopper and beetle - detailed observation of tagma in insects - Insect head orientation - Types of insect mouth parts and study of mandibulate and haustellate mouth parts - Types of insect antennae.
2. Observing insect thoracic sclerites - Types of insect legs and modifications - Wing venation, types of wings and wing coupling mechanism in insects.
3. Observing insect abdomen - modifications and appendages. Dissection and observation of genitalia of Orthoptera, Coleoptera, Lepidoptera and Hymenoptera.
4. Examining types of insect eggs, larvae and pupae. Chaetotaxy in insects.
5. Practicing micrometry in insects, insect imaging and microphotography.
6. Preparation of permanent slides of insects and insect parts.
7. Practicing methods of collection and preservation of insects including immature stages.
8. Hands on experience in diagnosing insect orders and their identification using taxonomic keys. Observing and keying out orders - Collembola, Protura, Diplura, Archaeognatha, Zygentoma, Ephemeroptera and Odonata.
9. Observing and keying out orders and families of insects - Plecoptera, Dermaptera, Embioptera, Orthoptera, Phasmatodea and Mantodea.
10. Observing and keying out orders and families of insects - Blattodea (roaches and termites) and Psocodea (free-living and parasitic).

11. Observing and keying out orders and families of insects– Thysanoptera and Hemiptera.
12. Observing and keying out orders and families of insects - Neuroptera, Megaloptera, Raphidioptera, Strepsiptera, Diptera, Mecoptera, Siphonaptera and Trichoptera.
13. Observing and keying out families of insect order Coleoptera.
14. Observing and keying out families of insect order Lepidoptera.
15. Observing and keying out families of insect order Hymenoptera.
16. Field visit to agricultural and horticultural, ecosystems to collect insects of different orders.
17. Field visit to forest and hill ecosystems to collect insects of different orders.

Course outcomes

- CO1:** Identify and describe the different body regions, sclerites, appendages and their modifications in insects and metamorphosis in insects. Interpret the need for specific modifications.
- CO2:** know differences between Taxonomy and Systematics and be expert in running taxonomic keys for identification of insects at family level.
- CO3:** Analyse diagnostic features of Non-insect orders, Exopterygote orders and Endopterygote orders.
- CO4:** Evaluating the insect species diversity in various ecosystems.
- CO5:** Create permanent slides and develop insect collection.

CO -PO Mapping

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

References

1. Beutel, R.G., F. Friedrich, S.Q. Ge and X.K. Yang. 2014. *Insect Morphology and Phylogeny: A textbook for students of Entomology*. De Gruyter, Berlin. 516 p.
2. Chapman, R.F. 2013. *The Insects: Structure and function*. Cambridge University Press, Edinburgh, Cambridge, UK, 961 p.
3. Gullan, P.J. and P.S. Cranston. 2010. *The Insects- An Outline of Entomology*, Wiley-Blackwell, Sussex, UK. 565 p.
4. ICZN. 1999. International Code of Zoological Nomenclature. UK. 106 p.
5. Richards, O.W. and R.G. Davies. 2014. *Imms' General Textbook of Entomology*, Volume I & II (10th Edition). Springer, UK. 1354 p.
6. Shaik, J. and K. Rajashekar. 2017. *Guide for Insect Morphology*. Educreation Publishing, New Delhi. 230 p.
7. Snodgrass, R. E. 1993. *Principles of Insect Morphology*. Cornell University Press, USA. 768 p.
8. Sreedevi.K, Naresh Meshram and P. R. Shashank. 2015. Insect Taxonomy – Basics to Barcoding In: *New Horizons in Insect Science: Towards Sustainable Pest Management* (ed.) A. K. Chakravarthy, Springer, India. 431 p.

9. Strickland E.H., B. Hocking and G.E. Ball. 2017. *A Laboratory Manual for Insect Morphology*, ReInk Books, S.N. Books world, New Delhi. 94 p.
10. Triplehorn, C.A. and N.F. Johnson. 2005. *Borror and DeLong's Introduction to the Study of Insects*. Thomson, USA, 888 p.

E-Resources

1. http://extension.oregonstate.edu/umatilla/sites/default/files/external_morphology.pdf
2. http://www.zoology.ubc.ca/bclepetal/Order%20Lepidoptera%20et%20al%20Text%20Files/order_lepidoptera.htm
3. <http://www.faculty.ucr.edu/~legnerref/entomol/exorthop.htm>
4. <http://www.waterbugkey.vcsu.edu/php/familylist.php?idnum=1&o=coleoptera>
5. <http://www.knowyourinsects.org/Key%20to%20Insect%20Orders.pdf>

ENT 612 INSECT ANATOMY, PHYSIOLOGY AND NUTRITION (2+1)

Learning objectives

- To gain knowledge about the anatomy and physiology of various systems in insects.
- Role of nutrition in growth and development of insects
- To gain skill on dissecting out various systems and identifying their anatomical modifications.
- To understand the basic biochemical processes as like cellular metabolism & its significance in energy generation.
- To gain hands on training in various biochemical lab assays.

THEORY

Unit I: Digestive and excretory physiology

History, importance and scope of insect physiology – Structure, modification and physiology of digestive system. Energy/ cellular metabolism – Carbohydrate metabolism – Glycolysis, Krebs' cycle, Oxidative phosphorylation. Metabolism of proteins and lipids – Role of fat bodies in metabolism. Structure, modification and physiology of excretory system. Homeostasis – Osmoregulation of water and salts – Excretion in aquatic and endo parasitic insects.

Unit II: Circulatory and respiratory physiology

Structure, modifications and physiology of circulatory system – Haemocytes – Immunity. Structure, modification and physiology of respiratory system – Physiology of gaseous exchange – Respiration in aquatic and parasitic insects – Role of respiration and haemolymph in thermoregulation.

Unit III: Neuro physiology, sense organs and muscles

Structure, modification and physiology of nervous system – Brief overview about ion channels – Neuro transmitters – Bio-chemical mechanism of nerve transmission. Sense organs – Structure and physiology of Photo – Chemo – and Mechano receptors. Sound & light production in insects. Basic structure and physiology of muscles.

Unit IV: Insect endocrinology and reproductive physiology

Endocrine glands – Structure, secretions – Brief overview about synthesis and functions of Prothoracicotropic hormone(PTTH), ecdysteroids, juvenile hormones, eclosion hormones and other minor hormones. Structure and modification of reproductive system – Physiology of vitellogenesis, oogenesis and spermatogenesis – Different types of reproduction.

Unit V: Insect embryology and nutritional physiology

Embryonic development in insects – Formation of different systems. Insect nutrition – Role of carbohydrates, proteins, lipids, vitamins, minerals, sterols in growth and development of insects. Role of extra and intra cellular microorganisms in nutrition Role of artificial diet.

Current trends in insect physiology and nutrition.

PRACTICALS

Study of anatomy of different systems of grasshopper, cockroach and blister beetle. Estimation of reducing sugar, proteins and lipids in insect tissue homogenates. Chromatographic analysis of free Aas in haemolymph. Estimation of acetyl choline and cholinesterase activity in insects. Determination of respiratory quotient. Studying endo symbionts in insects. Assessment of feeding efficiency and utilization of food by insects. Identification and estimation of haemocytes – Microtomy.

THEORY LECTURE SCHEDULE

1. History, importance and scope of insect physiology.
2. Basic structure of digestive system.
3. Modifications and physiology of digestive system.
4. Energy/ cellular metabolism. Carbohydrate metabolism – Glycolysis, Kreb's cycle, Oxidative phosphorylation.
5. Metabolism of proteins and lipids – Role of fat bodies in metabolism.
6. Structure, modification and physiology of excretory system.
7. Homeostasis – Osmoregulation of water and salts – Excretion in aquatic and endoparasitic insects.
8. Structure, modifications and physiology of circulatory system.
9. Haemolymph and types of haemocytes.
10. Physiological role of haemocytes and immunity.
11. Structure, modification and physiology of respiratory system.
12. Physiology of gaseous exchange.
13. Respiration in aquatic and parasitic insects.
14. Role of respiration and haemolymph in thermoregulation.
15. Structure of nervous system.
16. Physiology and modifications of nervous system – Brief overview about Ion channels and axonic conduction. Neuro transmitters, Bio-chemical mechanism of nerve transmission – Synaptic conduction.
- 17. Mid semester examination**
18. Sense organs – Structure and physiology of Photoreceptors.
19. Structure and physiology of Chemoreceptors.
20. Structure and physiology of Mechanoreceptors.
21. Sound & light production in insects. Basic structure and physiology of muscles.
22. Endocrine glands – Structure and secretions.
23. Brief overview about synthesis and functions of Prothoracicotropic hormone (PTTH), ecdysteroids, juvenile hormones, eclosion hormones

24. Brief overview about synthesis and functions of other minor hormones – PBANS, diuretic hormones etc.,
25. Structure and modification of reproductive system.
26. Physiology of vitellogenesis and oogenesis.
27. Physiology of spermatogenesis.
28. Different types of reproduction.
29. Embryonic development in insects.
30. Formation of different systems.
31. Insect nutrition – Role of carbohydrates, proteins and lipids in growth and development of insects.
32. Role of vitamins and minerals in growth and development of insects.
33. Role of sterols in growth and development of insects.
34. Role of extra and intra cellular microorganisms in nutrition.

PRACTICAL SCHEDULE

1. Dissection of cockroach / grasshopper / blister beetle to study anatomy of digestive system.
2. Dissection of silk cotton bug to study filter chamber.
3. Dissection of cockroach / grasshopper / blister beetle to study anatomy of reproductive system
4. Dissection of cockroach / grasshopper / blister beetle to study anatomy of nervous system. Observing ventral nerve cord and ganglia.
5. Dissection of cockroach / grasshopper / blister beetle to study anatomy of circulatory system. Studying heart beat in lepidopteran caterpillar.
6. Dissection of cockroach / grasshopper / blister beetle to study anatomy of respiratory system. Observing trachea, tracheoles and taenidial lining.
7. Estimation of reducing sugars in insect homogenates by DNS method.
8. Estimation of protein in insect homogenates by Lowry's method.
9. Estimation of lipids in insect homogenates by Bligh – Dyer method.
10. Paper chromatographic analysis of free Aas in haemolymph.
11. Thin layer chromatographic analysis of free Aas in haemolymph.
12. Estimation of acetyl choline and cholinesterase activity in insects.
13. Determination of respiratory quotient.
14. Studying endosymbionts in insects.
15. Comparison of feeding efficiency and utilization of artificial and natural diet by insects.
16. Identification and estimation of haemocytes
17. Practicing microtomy.

Course Outcomes

- CO1:** Capable of identifying structure, modification and physiology of digestive and excretory system. Describe their role in energy metabolism and Homeostasis respectively.
- CO2:** Describe Respiratory and Circulatory, Anatomy & Physiology and their role in thermoregulation.
- CO3:** Capable of identifying various components of Nervous system and describe ion channels and Nerve physiology can explain various sense organs and their

function. Describe role played by Endocrine glands and their Hormonal secretions can CO

CO4: Explain importance of Ecdysone and JH. Identify various Reproductive methods and physiology of reproduction.

CO5: Understand the Embryological growth in insects and development of various systems can explain role of various nutrients on the growth and symbionts impact on insects.

CO - PO Mapping

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

References

1. Chapman, R.F. 2012. *The Insects: Structure and Function*, Cambridge University Press, UK, 788 p.
2. Chapman, R.F., A.E. Douglas and S.J. Simpson. 2013. *The Insects: Structure and Function*, 5th Edition, Cambridge University Press, 929 p.
3. Chitra, K.C. 2016. *A Textbook of Insect Physiology*, Second Edition, Kalyani Publishers, New Delhi, 218 p.
4. Gullan, P. J. and P.S. Cranston. 2010. *The Insects - An Outline of Entomology*, Fourth Edition, Wiley - Blackwell Publishers, Oxford, 624 p.
5. Kerkut, G. A. and L.I. Gilbert. 1985. *Comprehensive Insect Physiology, Biochemistry and Pharmacology*, 13 Volumes, Pergamon Press, Oxford.
6. Klowden, M.J. 2013. *Physiological Systems in Insects*, Third Edition, Elsevier Inc., Netherlands, 696 p.
7. Nation, J. L. 2015. *Insect Physiology and Biochemistry*, Third Edition, CRC Press, New York, 644 p.
8. Novak, V.J. A. 1975. *Insect Hormones*, Second Revised edition, Chapman and Hall, London, 600 p.
9. Rockstein, M. 1974. *The Physiology of Insecta*, Second Edition, Elsevier Inc, 588 p.
10. Wigglesworth, V. B. 1972. *The Principles of Insect Physiology*, Springer, Netherlands. 827 p.

E-Resources

1. <http://krishikosh.egranth.ac.in/handle/1/2049010>
2. <file:///E:/967361.pdf>
3. file:///E:/2010-0012_rovarfiziologia_eng.pdf
4. <http://www.phthiraptera.info/Publications/47192.pdf>
5. <http://www.tandfonline.com/doi/pdf/10.4161/cib.23804>

ENT 613 INSECT ECOLOGY, PEST MANAGEMENT, STORAGE AND QUARANTINE ENTOMOLOGY (2+1)

Learning objectives

- To impart knowledge on the basic principles of insect ecology and Integrated pest management.

- To address various pests infesting stored produce and their management.
- To focus on threat due to invasive pests and the importance of quarantine regulations.
- To impart decision making skill in ecology based pest management protocols through AESA & sampling methods.
- To gain knowledge on various quarantine methods and laws.

THEORY

Unit I: Insect Ecology

History and Definition. Basic Concepts - Abundance and diversity of insects and relation between the two - Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology - Population growth - basic models - Exponential vs Logistic models (r and k strategists) Discrete vs Continuous growth models (J and S shaped growth) - Life Tables and their application - Case studies of insect life tables. Population dynamics - dispersal and migration, Seasonality in insects- Diapause (Quiescence) - aestivation, hibernation. Food as a limiting factor for distribution and abundance - Food chain - web and ecological succession. Biotic and abiotic factors influencing the insect abundance - Interspecific and intraspecific interactions - Defense mechanisms against predators/parasitoids. Community ecology.

Unit II: Concepts of IPM

Pest - definition, categories, biotypes, losses and causes for outbreaks - Ecological principles in pest management - economic threshold concepts (EIL and ETL) - tools of pest management and their integration; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys - Agro Ecosystem Survey Analysis.

Unit III: Components and implications of IPM

Legislative, cultural, physical, mechanical, host plant resistance, biological, botanical, chemical and other biorational methods - sterile male technique, chemosterilants, insect growth regulators, moult inhibitors, juvenile hormone mimics, antifeedants and repellants. Biotechnology in pest management - transgenic crops. Political, social and legal implications of IPM, pest and pesticide risk analysis, benefit cost ratio and partial budgeting. FFS and Plant clinic centres, IPM village - case studies of successful IPM programmes.

Unit IV: Stored produce pests and their management

Post-harvest losses of food grains in India due to insects, mites, rodents and birds. Factors responsible for grain losses. Sources of infestation. Identification, host range and biology of major stored grain pests and non-insect pests. Field and cross infestations - Ecology of insect pests of stored commodities / grains - moisture, temperature and humidity in safe storage of food grains. Stored grain deterioration process - physical and biochemical changes and consequences. Principles of safe grain storage, types of storage structures. Traditional grain storage practices. IPM for stored grain insect pests - prophylactic and curative measures using chemical and non-chemical methods. Safe use of pesticides with special emphasis on fumigants. Natural enemies of storage pests. Management of important mite, rodent and bird pests of storage.

Unit V : Quarantine principles and invasive pests

Quarantine principles and applications - Legislations adopted in India - Quarantine regulations of agricultural produce, seeds, plants and domestic material in international sea

and air ports. Quarantine laws – seed and seed health laws. Quarantine regulation for import and export of bio control agents – Case studies on successful import of biocontrol agents - Environmental Act, Insecticide act and registration procedure related to Quarantine. Invasive pests in India. **Current trends in insect pest management.**

PRACTICAL

Characterization of ecosystem, AESA, sampling methods- population estimation methods, symptoms and nature of damage. Crop loss assessment. Computation of EIL/ETL. Pest and pesticide risk analysis, BCR, FFS, Plant clinic centres. IPM for rice, cotton and tomato. Collection and identification of stored grains / seed insect pests and nature of damage caused by them; detection and estimation of insect infestation in stored food grains, stored grain insect detection gadgets; determination of moisture content in stored grains; familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality. Identification of Rodents and their management. Field visits to save grain campaign, central warehouse and FCI and institutions engaged in research or practice of grain storage. Visit to quarantine stations/NIPHM, Hyderabad to impart knowledge on different quarantine principles.

Assignment:

Each student has to collect and submit 5 number of stored product pests along with infested materials.

THEORY LECTURE SCHEDULE

1. Introduction and history of insect ecology - Concept, definition, importance.
2. Abundance and diversity of insects and their implications - Law of the Minimum, Law of Tolerance and biocoenosis.
3. Population growth – basic models - Exponential vs Logistic models (r and k strategists), Discrete Vs Continuous growth models (J and S shaped growth)
4. Life Tables and their application - Case studies of insect life tables.
5. Population dynamics - dispersal and migration, Seasonality in insects- Diapause (Quiescence) - aestivation, hibernation.
6. Food as a limiting factor for distribution and abundance, nutritional ecology, Food chain, web and ecological succession.
7. Abiotic factors influencing insect abundance - day degree concept.
8. Biotic factors influencing insect abundance - Interspecific and intraspecific interactions – Lotka – Volterra Model. Defense mechanism in insects – mimicry, colouration, concept of predator satiation.
9. Pest - definition, categories, biotypes, losses and causes for pest outbreaks.
10. History, origin and concepts of IPM - Ecological principles and economic threshold concepts.
11. Tools of pest management and their integration.
12. Pest survey and surveillance, forecasting, remote sensing methods and factors affecting surveys - Agro Ecosystem Survey Analysis.
13. Legislative, cultural, physical and mechanical methods of pest management.
14. Host plant resistance and biological methods in pest management.
15. Botanical methods of pest management.

16. Chemical methods of pest management.
- 17. Mid semester examination.**
18. Sterile male technique, chemosterilants and insect growth regulators in pest management - Moulting inhibitors, juvenile hormone mimics, antifeedants and repellants in pest management.
19. Biotechnology in pest management - transgenic crops.
20. Political, social and legal implications of IPM.
21. Pest risk analysis and pesticide risk analysis, Benefit cost -ratios and partial budgeting.
22. Farmers' Field School, Plant clinic centers and IPM Village.
23. Post-harvest losses of food grains in India due to insects, mites, rodents and birds - Factors responsible for grain losses. Sources of infestation.
24. Identification, host range and biology of major stored grain insect and non-insect pests.
25. Field and cross infestations - Ecology of insect pests of stored commodities / grains - moisture, temperature and humidity in safe storage of food grains.
26. Stored grain deterioration process - physical and biochemical changes and consequences.
27. Principles of safe grain storage, types of storage structures and traditional grain storage practices.
28. IPM for stored grain insect pests - prophylactic and curative measures by employing chemical and non-chemical methods.
29. Natural enemies of storage pests and Safe use of pesticides with special emphasis on fumigants.
30. Management of important mite, rodent and bird pests of stored commodities.
31. Quarantine principles and applications.
32. Legislations adopted in India - Quarantine regulations of agricultural produce, seeds, plants and domestic material in international sea and air ports.
33. Quarantine laws - seed and seed health laws. Quarantine regulations for import and export of bio control agents.
34. Environmental Act and registration procedure related to Quarantine. Invasive pests of India.

PRACTICAL SCHEDULE

1. Characterization of pond ecosystem and identification of food chain and web.
2. Agro ecosystem survey analysis in rice.
3. Practicing of sampling methods and population estimation.
4. Studying symptoms and nature of damage in crops.
5. Practicing of crop loss assessment and Computation of EIL and ETL.
6. Practicing pest surveillance - light traps/pheromone traps.
7. Pest risk analysis, pesticide risk analysis and benefit cost - ratios.
8. Procedure for organizing Farmers' Field School and concepts of IPM village and plant clinic center.
9. Practicing IPM in rice and coconut.
10. Collection and identification of stored grains / seed insect pests and their nature of damage. Identification of Rodents and their management.
11. Detection and estimation of insect infestation in stored food grains.

12. Studying stored grain insect detection gadgets.
13. Determination of moisture content in stored grains.
14. Observing various storage structures – Traditional, improved and modern.
15. Demonstration of preventive and curative measures and fumigation techniques.
16. Field visits to ‘Save Grain’ campaign, central warehouse and FCI warehouses.
17. Visit to quarantine station to impart knowledge on different quarantine principles.

Course Outcomes

- CO1:** Describe the role of ecology in population dynamics of insects and describe the link between ecology and pest management.
- CO2:** Explain concepts of IPM, ETL, EIL, role of sampling & AESA and capable of identifying & implementing various components of IPM.
- CO3:** Describe various stored product pests and their management.
- CO4:** Describe various Quarantine measures and legislation for export & import of Agricultural produce. Understand the importance of invasive insects and their impact on Agriculture.
- CO5:** Estimate pest intensity through damage assessment and implement pest management.

CO- PO Mapping

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

References:

1. Bhargava, M.C. and K.C. Kumawat. 2010. *Pests of Stored Grains and Their Management*, New India Publishing, New Delhi, 274 p.
2. Chapman, J.L. and M.J. Reiss. 2006. *Ecology: Principles and Applications*, Second edition, Cambridge University Press, UK, 330 p.
3. Dhaliwal, G.S. and R. Arora. 2003. *Integrated Pest Management – Concepts and Approaches*. Kalyani Publishers, New Delhi, 268 p.
4. Ignacimuthu, S.S. and S. Jayaraj. 2007. *Biotechnology and Insect Pest Management*. Elite Publishers, New Delhi, 244 p.
5. Khare, B.P. 2015. *Stored Grain Pests and Their Management*, Kalyani Publishers, New Delhi, 314 p.
6. Narayanasamy, P., S. Mohan and J.S. Awaknavar. 2009. *Pest Management in Stored Grains*. Satish Serial Publishing House, Delhi, India. 272 p.
7. Pedigo, L.P. and M.E. Rice. 2014. *Entomology and Pest Management*, Sixth edition, Waveland Pr. Inc., USA, 784 p.
8. Ranjeet Kumar. 2017. *Insect Pests of Stored Grain: Biology, Behavior and Management Strategies*. Apple Academic Press, USA, 394 p.
9. Redcliffe, E. B., W.D. Hutchinson and R.E. Cancelado. 2009. *Integrated Pest Management: Concepts, Tactics, Strategies and Case studies*, Cambridge University Press, UK, 549 p.
10. Southwood, T. R. E. and P.A. Henderson. 2000. *Ecological Methods*, Third Edition, Methuen and Co. Ltd., London, 592 p.

E-resources

1. https://en.wikipedia.org/wiki/Insect_ecology
2. <http://file.zums.ac.ir/ebook/760-Insect%20Ecology,%20Third%20Edition%20-%20An%20Ecosystem%20Approach=Timothy%20D.%20Schowalter=0123813514=Academ.pdf>
3. https://www.nrdnet.org/sites/default/files/integrated_pest_management.pdf
4. <https://cals.arizona.edu/apmc/docs/8%20Stored%20products-food,%20fabric%20F.pdf>
5. <https://www.appsnet.org/publications/kerruish/pp1.pdf>

ENT 621 TOXICOLOGY OF INSECTICIDES (2+1)**Learning objectives**

- To understand basic concepts of toxicology and to study about chemistry and mode of action of insecticides.
- To understand bioassay techniques
- To know about the formulation types
- To know the techniques to overcome the residue and resistance problems

THEORY**Unit I: Principles of toxicology**

Toxicology – definition – branches - Insect toxicology – History. Toxicity evaluation – dose – response relationship – NOEL, LOEL – Median lethality concept – Toxicity parameters.

Unit II: Classification and chemistry of insecticides

Classification of insecticides based on mode of entry – mode of action - IRAC – toxicity range – chemical classification. Chemistry and important characteristics of major groups of insecticides viz., inorganic, organic and synthetic organics. Bio rationals – antifeedants, repellants, chemosterilants, IGRs, pheromones and neuropeptides. Rodenticides, acaricides and nematocides.

Unit III: Mode of action of insecticides and rodenticides

Mode of action of major groups of insecticides viz., inorganic, organic and synthetic organics. Brief overview on structure – activity relationship. Synergism, antagonism and potentiation. Compatibility, phytotoxicity and shelf life. Mode of action of acute and chronic rodenticides.

Unit IV: Insecticide metabolism and consequences of insecticide usage

Metabolism of insecticides - Phase I and II reactions in mammals. Consequences of insecticides usage – Insecticide resistance – Types – Molecular mechanisms– Insecticide resistance management. Pest resurgence. Insecticide residues – Hazards to human, animals, pollinators and wildlife – Concepts in relation to residues – ADI, MRL, waiting period – Principles and methods of residue analysis.

Unit V: Insecticide industry and development of insecticides

Potential molecular targets. Pipeline compounds. Pesticide use and insecticide industry in India. Insecticide development. Insecticide Act 1968 and Rules 1971 and amendments – Registration of insecticides – Procedure and data requirement. Basic toxicological assessment procedures – acute oral, dermal, inhalation toxicities – Ethics in animal use.

Current trends in insecticide Toxicology.

PRACTICALS

Rearing of test insects – various bioassay techniques – determination of LC₅₀ and LD₅₀ of insecticides – bracketing – Probit analysis – graphical method and Finney's method – Green house evaluation of insecticides – principles of field evaluation of insecticides – Physical properties of various formulations of insecticides. Carriers and adjuvants in insecticide formulations. Determination of synergistic activity – determination of resistance ratio, susceptibility index – determination of diagnostic dose – studies on compatibility and phytotoxicity of insecticides – safety evaluation of insecticides towards natural enemies and pollinators – pesticide residue analysis. Visit to pesticide residue analysis lab or toxicological evaluation centres.

THEORY LECTURE SCHEDULE

1. Toxicology - definition and branches. Insect toxicology- Definition and History.
2. Toxicity evaluation – Dose – response relationship – NOEL, LOEL – Median lethality concept.
3. Toxicity parameters.
4. Classification of insecticides based on mode of entry and toxicity ranges.
5. Classification of insecticides based on mode of action - IRAC.
6. Classification based on chemical nature.
7. Chemistry and important characteristics of inorganic insecticides.
8. Chemistry and important characteristics of organic insecticides
9. Chemistry and important characteristics of synthetic organic insecticides - I.
10. Chemistry and important characteristics of synthetic organics - II.
11. Brief chemistry and important characters of antifeedants, repellants and chemosterilants.
12. Brief chemistry and important characters of IGRs.
13. Brief chemistry and important characters of pheromones and neuropeptides.
14. Rodenticides, acaricides, nematocides –chemistry, mode of action, characteristics.
15. Mode of action of insecticides – Metabolic inhibitors.
16. Mode of action of insecticides – Insect growth regulators.
- 17. Mid semester examination**
18. Mode of action of insecticides – Axonic poisons
19. Mode of action of insecticides – Synaptic poisons
20. Mode of action of insecticides – Neuro muscular joints and other types.
21. Brief overview on structure – activity relationship.
22. Synergism, antagonism and potentiation.
23. Compatibility, phytotoxicity and shelf life.
24. Mode of action of acute and chronic rodenticides.
25. Metabolism of insecticides - Phase I and II reactions in mammals.
26. Insecticide resistance – Types – Molecular mechanisms. Insecticide resistance management.
27. Pest resurgence. Insecticide residues – Hazards to human, animals, pollinators and wildlife – Concepts in relation to residues – ADI, MRL, waiting period.
28. Principles and methods of pesticide residue analysis.
29. Pesticide use and insecticide industry in India.

30. Insecticides development.
31. Potential molecular targets. Pipeline compounds.
32. Insecticide Act 1968 and Rules 1971 and amendments.
33. Registration of insecticides – Procedure and data requirement.
34. Basic toxicological assessment procedures – acute oral, dermal, inhalation toxicities – Ethics in animal use.

PRACTICAL SCHEDULE

1. Mass culturing of test insects – Pulse beetle, *Spodoptera* and Aphids.
2. Practicing various bioassay techniques.
3. Preparation of test solutions for bio assays. Determination of LC₅₀ and LD₅₀ of insecticides and bracketing.
4. Probit analysis – graphical method and Finney's method.
5. Practicing greenhouse evaluation of insecticide.
6. Learning principles of field evaluation of insecticides.
7. Studying the properties of various formulations of insecticides.
8. Carriers and adjuvants in insecticide formulations.
9. Determination of synergistic activity.
10. Determination of resistance ratio, susceptibility index.
11. Determination of diagnostic dose.
12. Studies on compatibility assessment of insecticides with other agrochemicals.
13. Phytotoxicity assessment of insecticides.
14. Safety evaluation of insecticides towards natural enemies and pollinators.
15. Pesticide residue analysis in various matrices (plant, soil and water).
16. Learning basic toxicological assessment procedures such as acute, oral and dermal toxicities.
17. Visit to pesticide residue analysis lab and toxicological evaluation centers.

Course Outcomes

- CO1:** Knowledge on the response of animals/insects to poisons and their measurements.
- CO2:** Familiarity with different types of pesticide classifications and their chemistry.
- CO3:** Knowing the target sites of pesticides, their actions, how can the activity be increased, compatibility among chemicals and phytotoxicity grading.
- CO4:** Understanding the degradation of insecticides in environment, plants and animals. Knowing of methods to handle insecticides and to estimate residues and waiting period.
- CO5:** Collective idea about the pesticide usage and industries in globe and India. Knowledge on enforcement of insecticide act, registration of insecticides, development of toxicology data and ethics in animal use.

CO-PO Mapping

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

References

1. Copping, L. G. and H.G. Hewitt. 1998. *Chemistry and Mode of Action of Crop Protection Agents*. The Royal Society of Chemistry, London. 145 p.
2. Gupta, HCL, 2001. *Insecticides Toxicology and Uses*, Agrotech Publishing Academy, New Delhi, 478 p.
3. Ishaaya, I. and D. Degheele. 1998. *Insecticides with Novel Modes of Action: Mechanisms and Application*, Springer and Verlag Berlin, 289 p.
4. Ishaaya, I., R. Nauen and A.R. Horowitz. 2007. *Insecticides Design Using Advanced Technologies*, Springer and Verlag, Berlin, 305 p.
5. Kranthi, K.R. 2005. *Insecticide Resistance -Monitoring, Mechanisms and Management Manual*. CICR, Nagpur, 153 p.
6. Matsumura, F. 1985. *Toxicology of Insecticides*. Plenum Press, New York. 502 p.
7. Perry, A.S., I. Yamamoto, I. Ishaaya and R. Perry. 1998. *Insecticides in Agriculture and Environment: Retrospects and prospects*. Springer and Verlag, New York, 261 p.
8. Regupathy, A. and K.P. Dhamu. 2003. *Statistics work book for insecticide toxicology*. Suriya Desktop Publishers, Coimbatore, 177 p.
9. Singh, D.K. 2012. *Pesticide Chemistry and Toxicology, Volume 1, Toxicology: Agriculture and Environment*, Bentham Science Publishers, UAE, 142 p.
10. Yu, S. J. 2014. *The Toxicology and Biochemistry of Insecticides*, Second Edition, CRC Press, New York. 380 p.

E-resources

1. <http://nsdl.niscair.res.in/jspui/handle/123456789/226>
2. http://www.fssai.gov.in/dam/jcr:34b311bb-4141-4a41-ad92-65e9258c2bc5/Manual_Pesticides_Residues_09_01_2017.pdf
3. <http://www.iraonline.org/>
4. <https://pdfs.semanticscholar.org/a81f/1625f186ecaf990bd7e1452a290a98e6feb0.pdf>
5. R. Bloomquist, Jeffrey. (1996). Ion Channels as Targets for Insecticides. Annual review of entomology. 41. 163-90. 10.1146/annurev.en.41.010196.001115

ENT 622 BIOLOGICAL INSECT PEST SUPPRESSION (2+1)

Learning objectives

- To study the basics and role of bio control agents in insect pest management.
- To study the mass production techniques of important biological control agents
- To study the field evaluation techniques of important biological control agents

THEORY

Unit I: Basics of biological control

Biological control - definition, history, scope, principles, successful case histories of biocontrol agents and concepts. Natural, applied and classical biological control. Scope of biological insect pest suppression -use of living organisms and their products, parasitoids, predators, entomopathogens, entomophilic nematodes, predatory mites, spiders, botanicals and semiochemicals.

Unit II: Insect parasitoids and predators

Insect Parasitoids - types, desirable attributes, important groups, biology, adaptation, host selection behavior, mass production and field release. Insect predators - types, desirable attributes, important groups, biology, adaptation, host seeking behavior, mass production and field release. Tritrophic interaction of parasitoids and predators.

Unit III: Entomopathogens and entomophilic nematodes

Entomopathogens – important groups – Bacteria, viruses, fungi, protozoans and rickettsiae - host range, symptoms of infections and desirable attributes. Nematodes – important groups, host range, symptoms of attack, mass production and field release.

Unit IV: Non insect predators and weed killers

Predatory mites – important species, host range, biology and host seeking behavior. Spiders – important species, host range, biology and host seeking behavior. Predatory birds of agricultural importance. Weed killers-desirable attributes of weed killers – major weeds and their biocontrol agents.

Unit V: Implications of bio-control

Factors affecting efficacy of biocontrol agents conservation and augmentation, integration with IPM components, role of weeds and mixed/trap cropping and dirty field technique in enhancing natural enemy activity, future possibilities of biological control, importations of natural enemies – quarantine regulations in utilization of exotic biocontrol agents, role of biotechnology and semiochemicals in biological control. **Current trends in Biological insect pest suppression.**

Practical

Field survey for collection of parasitoids using various methods, host rearing, net sweep and traps in agricultural and horticultural ecosystems. Diagnosis and sketching of parasitoids, predators and entomopathogens. Establishing tritrophic relationship of parasitoids and predators. Identification of predatory mites and spiders. Mass production techniques of parasitoids – *Trichogramma*, *Goniozus* and *Brachymeria*; Predators- *Chrysopa* and coccinellids. Pathogenicity and mass production of entomopathogens – NPV, *Metarrhizium* and *Bt*. Mass production of entomophilic nematodes. Field release and evaluation of parasitoids and predators.

Assignment:

Each student has to submit 50 numbers of bio control agents comprising parasitoids, predators and non insect predators (at least 10 should be from host rearing).

THEORY LECTURE SCHEDULE

1. Biological insect pest suppression – definition and scope - use of living organisms and their products.
2. History and development of biological control in India and abroad.
3. Principles and successful examples of biocontrol.
4. Natural, applied and classical biological control – definition and difference.
5. Classification of bio control agents – parasitoids, predators, entomopathogens, entomophilic nematodes, predatory mites, spiders, botanicals, semiochemicals and weed killers.
6. Insect parasitoids – types, desirable attributes and important groups.
7. Biology of important parasitoids.
8. Host selection behaviour of parasitoids.
9. Biological characteristics of adult parasitoids.
10. Mass production, economics and field release of parasitoids.
11. Insect predators – types, desirable attributes and important groups including vertebrate predators.

12. Biology, adaptation and host seeking behaviour of predators.
13. Mass production, economics and field release of predators.
14. Entomopathogens – Bacteria – important groups, examples, host range, symptoms of infections and desirable attributes.
15. Entomopathogens – Viruses – important groups, examples, host range, symptoms of infections and desirable attributes.
16. Entomopathogens – Fungi – important groups, examples, host range, symptoms of infections and desirable attributes.

17. Mid semester examination

18. Entomopathogens – Protozoans and Rickettsiae – important groups, examples, host range, symptoms of infections and desirable attributes.
19. Mass production, formulation, economics and field application of entomopathogens.
20. Tritrophic interaction – host plant - host insect - parasitoid/predator
21. Entomophilic nematodes – important groups, host range and symptoms of attack.
22. Mass production, formulation and field application of entomophilic nematodes.
23. Predatory mites – important species, host range, biology and host seeking behaviour.
24. Predatory Spiders - important species and host range.
25. Predatory Spiders - biology and host seeking behaviour.
26. Weed killers – desirable attributes and important species.
27. Weed killers – host range and biology.
28. Factors affecting efficacy of bio control agents.
29. Conservation techniques in improving efficiency of NE.
30. Augmentation of bio control agents.
31. Integration of IPM components, role of weeds/refugia mixed / trap crop and dirty field technique in enhancing natural enemy activity.
32. Future possibilities of biological control, importation of natural enemies -Quarantine regulation in utilisation of exotic bio-control agents.
33. Role of biotechnology in biological control.
34. Role of semiochemicals in biological control.

PRACTICAL SCHEDULE

1. Identification and sketching of important Chalcidoidea parasitoid families of agricultural importance.
2. Identification and sketching of other parasitoid families of agricultural importance.
3. Identification and sketching of important insects predators of agricultural importance.
4. Identification and sketching of other invertebrate and vertebrate insect predators.
5. Identification and sketching of important entomopathogens and entomophilic nematodes of agricultural importance.
6. Identification and sketching of important predatory mites, spiders and weed killers of agricultural importance.
7. Mass production techniques of *Trichogramma* and *Brachymeria*.
8. Mass production techniques of *Chrysopa* and *Coccinellids*.
9. Practicing tritrophic interaction.
10. Mass production techniques of NPV.

11. Pathogenicity of NPV to *Helicoverpa /Spodoptera* and *Metarrhizium* to Rhinoceros beetle grub.
12. Mass production techniques of *Metarrhizium* and *Beauveria*.
13. Mass production techniques of *Bacillus thuringiensis* and Spore staining.
14. Pathogenicity of *Bt* to *Helicoverpa / Plutella*.
15. Experimentation of semiochemicals in host selection.
16. Experiment on compatibility of biocontrol agents with botanicals and agro chemicals.
17. Visit to NBAIR / production unit of biocontrol agents.

Course Outcomes

- CO1:** Describe about the biological control agents like Predators, parasitoids, pathogens and others
- CO2:** Illustrate biology, adaptations, mass production and release techniques of insect predators and parasitoids
- CO3:** Explain about bacteria, viruses, fungi, protozoans and rickettsiae and their symptoms of infections, mass production and field release.
- CO4:** Describe about role of non insect predators and weed killers in biocontrol programmes
- CO5:** Have knowledge on implications of biocontrol programmes, successful stories and utilization of exotic natural enemies

CO -PO Mapping

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

References:

1. Clausen, C.P. 1940. Entomophagous Insects. McGraw Hill Book Company, USA, 687 p.
2. Consoli, F., L. Parra, R.P. José and R. Zucchi. 2010. *Egg Parasitoids in Agroecosystems with Emphasis on Trichogramma*, Springer, Netherlands, 482 p.
3. Coppel, H.C. and J.W. Mertins. 2011. *Biological Insect Pest Suppression*, Springer-Verlag, New York, 314 p.
4. De Bach, P. 1970. *Biological Control of Insect Pests and Weeds*, Chapman and Hall Ltd., London, 844 p.
5. De Bach, P. 1979. *Biological Control by Natural Enemies*, Cambridge University Press, London, 323 p.
6. Singh, S.P. 2004. *Some success stories in Classical Biological control of Agricultural pests in India*, Asia-Pacific Association of Agricultural Research Institutions, FAO Regional office for Asia and the Pacific, Bangkok, Thailand, 73 p.
7. Sithanatham, S., C.R. Ballal, S.K. Jalali and N. Bakthavatsalam. 2013. *Biological Control of Insect Pests using Egg Parasitoids*, Springer, India, 424 p.
8. Tandon, P.L., C.R. Ballal, S.K. Jalali and R.J. Rabindra. 2003. *Biological Control of Lepidopteran Pests*. Society for Biocontrol Advancement, NBAIR, Bangalore, India, 354 p.
9. Vega, F.E. and H.K. Haya. 2012. *Insect Pathology*, Academic Press, New York, 502 p.
10. Waterhouse, D.F. and D.P.A. Sands. 2001. *Classical Biological Control of Arthropods in Australia*. CSIRO Entomology, Canberra, Australia, 559 p.

E-resources:

1. <http://www.nhm.ac.uk/chalcidoids>
2. http://osuc.biosci.ohio-state.edu/hymDB/eol_scelionidae.home
3. www.nbair.res.in/IndianMymaridae/index.php
4. www.nbair.res.in/Chalcididae/index.php
5. www.nbair.res.in/Aphelinidae/index.php

ENT 623 PESTS OF CROPS AND THEIR MANAGEMENT (2+1)

Learning objectives

- To study the distribution, bionomics and symptoms of damage of pests of crops and storage.
- To distinguish various symptoms of damage and identify different life stages of the major pests of crops and storage
- To discuss integrated pest management protocols for major crops and pests
- To perform rearing and collection of major pests for better understanding of their biology and identification characters

THEORY

Unit I: Pests of cereals, millets and pulses

Cereals: Rice, Wheat and Maize; Millets; Pulses: Red gram, Black gram, Green gram, Bengal gram, Cowpea, Pea, Lab lab and Soybean.

Unit II: Pests of oilseeds, fibre and sugar crops, masticatories, green manures and forage crops

Oil seeds: Groundnut, Sesame, Sunflower, Safflower, Castor and Mustard; Fibre Crops: Cotton and Jute; Sugar Crops: Sugarcane and Sugarbeet; Masticatories: Tobacco, Arecanut and Betelvine; Green manures and Forage crops.

Unit III : Pests of vegetables, tubers, spices and condiments, plantation and beverage crops

Vegetables: Brinjal, Bhendi, Tomato, Crucifers, Cucurbits, Moringa and Amaranthus; Tuber crops: Potato, Sweet potato, Tapioca and Yam; Spices and condiments: Pepper, Cardamom, Cinnamon, Chillies, Onion, Garlic, Ginger, Turmeric, Coriander, Curry leaf, Tamarind and Mint; Plantation crops: Coconut, Oil palm; Beverage crops: Coffee, Tea and Cocoa.

Unit IV: Pests of fruits and flowers

Tropical fruits: Mango, Sapota, Citrus, Banana, Grapevine, Guava, Cashew, Jack, Pomegranate, Pineapple, Papaya, Ber; Temperate fruits: Apple, Plum, Peach and others; Flower crops: Rose, Jasmine, Chrysanthemum, Crossandra, Tube rose, Marigold and Nerium.

Unit V: Pests of tree, lawn, ornamental and medicinal plants, mushroom, green house crops, locusts, non-insect pests and insect vectors of plant diseases

Tree Crops: Neem, Teak, Sandalwood, Eucalyptus, Casuarina; Pests of Lawn; Ornamental crops: Crotons, Gladiolus, Gerbera, Lily and Carnation; Medicinal plants: Ocimum, Senna, Periwinkle, Glory lily, Ashwagandha, Aloe and Noni; Mushroom pests; Green house pests; Non-insect pests: Rodents, mites, nematodes and birds; Locusts; Insect vectors of plant diseases – Major groups and major diseases transmitted by them. **Current trends in crop pests and their management.**

PRACTICAL

Identification of symptoms of damage and life stages of important pests of different field and horticultural crops - Cereals, Millets, Pulses, Oilseeds, Fibre, Sugarcane, Masticatories,

Green Manures, Forage Crops, Vegetables, Tubers, Spices and Condiments, Plantations, Beverages, Fruits, Flowers, Ornamental, Medicinal Plants, Tree, Lawn, Mushroom, Green house crops, Non-insect pests, Locusts, Insect Vectors of Plant diseases.

Assignment: Each student has to submit 25 major insect pests as rearings and 50 insect pests as preserved/mounted/carded specimens from field and horticultural crops.

THEORY LECTURE SCHEDULE

Economic importance, distribution, seasonal incidence, host range, bionomics and Integrated pest management strategies of major insect and non-insect pests of following crops:-

1. Rice – borers and leaf feeders.
2. Rice – sucking pests and non-insect pests.
3. Wheat and maize.
4. Minor millets.
5. Pulses.
6. Groundnut, sesame.
7. Sunflower, safflower, castor and mustard.
8. Sugarcane and sugarbeet.
9. Cotton and jute.
10. Tobacco, arecanut and betelvine.
11. Green manures and forage crops.
12. Brinjal, bhendi, tomato.
13. Cucurbits.
14. Crucifers.
15. Moringa and amaranthus.
16. Tuber crops - Potato, sweet potato, tapioca and yam.
17. **Mid Semester Examination**
18. Pepper, cardamom, cinnamon.
19. Chillies, onion, garlic.
20. Ginger, turmeric and coriander, curry leaf, tamarind and mint.
21. Coconut and oil palm.
22. Coffee.
23. Tea and cocoa.
24. Mango, sapota and citrus.
25. Banana, grapevine, guava, cashew.
26. Jack, pomegranate, pineapple, papaya and ber.
27. Apple, plum, peach and others.
28. Rose, jasmine, chrysanthemum, crossandra, tuberose, marigold and nerium.
29. Neem, teak, sandalwood, eucalyptus and casuarina.
30. Lawn; Ornamental crops: Crotons, gladiolus, gerbera, lily and Carnation.
31. Ocimum, senna, periwinkle, glory lily, ashwagandha, aloe and noni.
32. Mushroom pests; Green house pests; Non insect pests.
33. Rodents, mites, nematodes and birds.

34. Locusts; insect vectors of plant diseases – Major groups and major diseases transmitted by them.

PRACTICAL SCHEDULE

Identification of symptoms of damage and life stages of important pests of following field and horticultural crops

1. Cereals: Rice maize.
2. Wheat and millets.
3. Pulses.
4. Oilseeds: Groundnut, sesame, sunflower, safflower, castor and mustard.
5. Sugar crops: Sugarcane and sugarbeet.
6. Fibre crops: Cotton and jute.
7. Masticatories: Tobacco, arecanut and betelvine, green manures and forage crops.
8. Pests of Vegetables: brinjal, bhendi, tomato, cucurbits, crucifers, moringa and amaranthus.
9. Tuber crops: Potato, sweet potato, tapioca and yam.
10. Spices and condiments - Pepper, cardamom, clove, nutmeg, chillies, onion, garlic, ginger, turmeric, coriander, curry leaf, tamarind and mint.
11. Plantation and beverage crops: Coconut, oil palm, rubber, coffee, tea and cocoa.
12. Tropical fruits: Mango, sapota and citrus, banana, grapevine and guava.
13. Tropical fruits: Cashew, jack, pomegranate, pineapple, papaya, ber, date palm, jamun; temperate fruits: Apple, plum, peach and others.
14. Flower crops: Rose, jasmine, chrysanthemum, crossandra, tuberose, marigold and nerium. Tree crops: Neem, teak, sandalwood, eucalyptus and casuarina.
15. Pests of Lawn; Ornamental crops: Crotons, gladiolus, gerbera, lily and carnation. Medicinal plants: Ocimum, senna, periwinkle, glory lily, ashwagandha, aloe and noni.
16. Mushroom pests; Green house pests; Non-insect pests: Rodents, mites, nematodes and birds.
17. Locusts; Insect vectors of plant diseases – Major groups.

Course Outcomes

- CO1:** Define bionomics, symptoms of damage and integrated management strategies for pests of cereals, millets and pulses
- CO2:** Discuss bionomics, symptoms of damage and integrated management strategies for pests of Oilseeds, Cotton, Sugarcane, Green Manures, Forage Crops and Tobacco
- CO3:** Explain bionomics, symptoms of damage and integrated management strategies for pests of Vegetables, Tubers, Spices and Plantations
- CO4:** Define bionomics, symptoms of damage and integrated management strategies for pests of Fruits and Ornamentals
- CO5:** Discuss bionomics, symptoms of damage and integrated management strategies for pests of Medicinal Plants Tree, Lawn, Mushroom and green house crops
- CO6:** Illustrate identification and biology of major pests of crops and storage through rearing and collection.

CO -PO Mapping

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

References:

1. Awasthi, V.B. 2007. *Agricultural Insect Pests and their Control*, Scientific Publishers India, Jodhpur, 267 p.
2. Butani, D.K. and M.G. Jotwani 2017. *Insects in Vegetables*, Daya Publishing House, New Delhi, 356 p.
3. Chavai, A.M. 2015. *Identification and Management of Horticultural Pests*, New India Publishing Agency, New Delhi. 378 p.
4. Dhaliwal G.S. and O. Koul. 2011. *Biopesticides and Pest Management*, Kalyani Publishers, India, 386 p.
5. Kannan, R., C. Kathirvelu and R. Veeravel. 2016. *Crop Pest Management*, Manibharathi Publications, Chidambaram, 456 p.
6. Marcelo, L.L. and S. Sonia. 2012. *Integrated Pest Management and Pest Control – Current and Future Tactics*, InTech Publishers, New Delhi, 682 p.
7. Regupathy, A. and R. Ayyasamy. 2015. *A Guide on Crop Pests*, Namrutha Publications, Coimbatore. 385 p.
8. Sathe, T.V. 2017. *Pests of Ornamental Plants*, Daya Publishing House, New Delhi, 199 p.
9. Srivastava, K.P. 2013. *A Text Book of Applied Entomology*, Part – II. Kalyani Publishers, India, 305 p.
10. Vasantharaj David, B. and V.V. Ramamurthy. 2016. *Elements of Economic Entomology*, Eighth Edition, Brillion Publishing, New Delhi. 625 p.

E-resources

- www.knowledgebank.irri.org/step-by-step-production/growth/pests-and-diseases/insects
- <http://www.rkmp.co.in/category/eistags/eis/production-know-how/crop-protection/insects/insect-pests-of-national-importance>
- <http://www.ncipm.org.in/nicra/NICRAPDFs/Manuals/Manual%20for%20Rice%20Pest%20Surveillance.pdf>
- http://agritech.tnau.ac.in/crop_protection/crop_prot_crop_insect_pest.html
- <http://farmer.gov.in/ipmpackageofpractices.html>

ENT 624 PLANT RESISTANCE TO PESTS (2+1)**Learning objectives**

- To familiarize with importance of plant resistance, host searching behaviour in relation to host plant and environmental impact of resistance.
- To impart knowledge on morphological, anatomical and bio chemical basis of resistance.
- To make students familiar with biotechnological approaches in HPR and development of transgenic plants.

THEORY**Unit I: Basics of host plant resistance**

Host plant resistance – History, importance, definitions – advantages and disadvantages – Insect-host plant relationship – Host selection process by insects- role of allelochemicals in host selection.

Unit II: Mechanisms and factors of resistance

Classification of resistance – ecological/pseudo resistance – host evasion, escape and induced resistance. Genetic resistance. Mechanisms of resistance – antixenosis, antibiosis and tolerance. Biophysical factors – Trichomes – Glandular, non-glandular and other morphological characters. Biochemical factors – volatiles and secondary plant substances, chemical ecology, tritrophic relations.

Unit III: Genetic and induced resistance

Genetics of crop resistance to insects, factors influencing resistance, breeding for resistance – methods – problems and prospects. Stability of resistance – biotype development and measures to combat biotypes. Induced resistance – Elicitors – Forms of IR – ISR, SAR – Mechanisms; Plant defense – Phytohormones – JA, SA Pathways- Role of endophytes.

Unit IV: Insect resistance in major crops

Successful examples of resistant crop varieties in India and world – resistance to key pests in rice, maize, sorghum, sugarcane, cotton, pulses, oilseeds, vegetable and fruit crops – achievements and future thrusts – Methods of evaluation of resistance.

Unit V: Biotechnological approaches in plant resistance

Biotechnological tools in host plant resistance –utilization of wild species – identification of genes responsible for resistance. Marker aided selection – Incorporation of genes for resistance into crop varieties – transgenic crops, their status, scope and limitations. Molecular techniques – cloning. **Current trends in plant resistance to pests.**

PRACTICAL

Mass culturing of homopteran and lepidopteran insects for screening. Screening methodologies and evaluation techniques for resistance to key pests in rice, sorghum, pulses, cotton, sugarcane and vegetables. Antixenosis and antibiosis mechanisms of resistance to major pests in rice, cotton, and vegetables. Estimation of biophysical and biochemical factors of resistance. Important nutritional factors imparting resistance – carbohydrates, phenols etc.

THEORY LECTURE SCHEDULE

1. History, importance and definition, status, scope, and limitations of plant resistance to pests.
2. Insect – host plant relationship – host selection by phytophagous insects.
3. Classification of host plant resistance.
4. Mechanisms of resistance – antixenosis.
5. Mechanisms of resistance – antibiosis and tolerance.
6. Biophysical factors of resistance – Trichomes and other morphological characters.
7. Bio chemical factors of resistance- volatile and secondary plant substances; Chemical ecology – tritrophic relations.
8. Genetic basis of resistance, abiotic and biotic factors influencing resistance in plants
9. **Mid semester examination**
10. Breeding for resistance – methods, problems and prospects.

11. Stability of resistance – insect biotypes – development and their management.
12. Induced resistance – Elicitors – Forms of IR – ISR, SAR – Mechanisms; JA, SA Pathways- Role of endophytes, Exogenous application of elicitors.
13. Successful examples, future thrusts of insect resistance in crop varieties in India and world – cereals, millets, insect resistance in sugarcane, cotton and pulses.
14. Successful examples, future thrusts of insect resistance in crop varieties in India and world – oilseeds, fruits and vegetables.
15. Biotechnological tools in host plant resistance.
16. Utilization of wild species – identification and incorporation of genes of interest and marker aided selection.
17. Genetic engineering and plant resistance – status, scope and limitations of transgenic crop varieties.

PRACTICAL SCHEDULE

1. Mass culturing of rice brown planthopper / aphids / whiteflies
2. Mass culturing of diamond back moth / *Spodoptera* / *Helicoverpa* / rice leaf folder
3. Green house methodology for screening of rice varieties against brown planthopper; standard seed box test and modified seed box for grading and grouping.
4. Methodology and evaluation of resistance in rice to stem borer and leaf folder.
5. Methodology and evaluation of resistance in sorghum to key insect pests.
6. Methodology and evaluation of resistance in cotton to key insect pests.
7. Methodology and evaluation of resistance in sugarcane to key insect pests.
8. Methodology and evaluation of resistance in vegetables to key insect pests.
9. No- choice test for studying preference / non- preference of rice / cotton / tomato / bhendi varieties against major insect pests.
10. Locating feeding punctures of green leaf hopper on resistant and susceptible rice varieties using safranin dye technique.
11. Growth and development of brown plant hopper / leaf folder on resistant and susceptible rice varieties – no choice test for studying antibiosis.
12. Studying feeding preference of brown plant hopper in resistant and susceptible rice varieties.
13. Estimation of biophysical factors of resistance in the foliage of rice / cotton / bhendi / tomato varieties.
14. Estimation of biophysical factors of resistance in the fruits of tomato / bhendi, cotton bolls and bracts and sesame capsules.
15. Estimation of total and O.D. phenols in tomato / cotton varieties and silica in rice varieties.
16. Estimation of reducing and non – reducing sugars in tomato / bhendi varieties.
17. Estimation of secondary substances in crop varieties – gossypol in cotton, tomatine/lycopene in tomato and solanin in brinjal.

Course Outcomes

- CO1:** Understand the importance of plant resistance, host searching behavior in relation to plant factors, environmental impact of resistance and factors influencing expression of resistance.
- CO2:** Capable to explain about the morphological and anatomical basis of resistance.

CO3: Describe about the bio chemical basis of resistance and bio chemistry of induced resistance.

CO4: Explain about the biotechnological approaches in host plant resistance.

CO5: Capable of utilizing the resistant varieties in IPM and explain about the methods in development of transgenic plants.

CO-PO Mapping

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

References

1. Arora, R. and S. Sandhu. 2017. *Breeding Insect Resistant Crops for Sustainable Agriculture*, Springer, Berlin, 421 p.
2. Dhaliwal, G.S. and R. Singh. (Eds.). 2004. *Host Plant Resistance to Insects – Concepts and Applications*, Panima Publishing Corporation, New Delhi, 578 p.
3. Dhaliwal, G.S. and Dilawari, V.K. 1993. *Advances in Host plant Resistance to Insects*, Kalyani Publishers, New Delhi, 443 p.
4. Painter, R.H. 1951. *Insect Resistance in Crop Plants*, The Mac Millan Co., New York. 520 p.
5. Panda, N. and G.S. Khush. 1995. *Host Plant Resistance to Insect Pests*, CAB International, Walling Ford, 431 p.
6. Sadasivam, S. and B. Thayumanavan. 2003. *Molecular Host Plant Resistance to Pests*, Marcel Dekker, New York, 479 p.
7. Sharma, H.C. 2014. *Biotechnological Approaches for Pest Management and Ecological Sustainability*, CRC Press, USA, 526 p.
8. Smith, C.M. 2005. *Plant Resistance to Arthropods – Molecular and Conventional Approaches*, Springer, Berlin, 423 p.
9. Smith, C.M., Z.R. Khan and M.D. Pathak. 1994. *Techniques for Evaluating Insect Resistance in Crop Plants*, CRC Press Inc., USA, 320 p.

E-References

1. <http://www.icrisat.org/>
2. <http://iapreviews.ars.usda.gov/research/docs.htm?docid=22702>
3. <http://www.crrl.nic.in/>
4. <http://hau.ernet.in/>
5. <https://entomology.k-state.edu/department-info/links/painter-collection.html>

MINOR COURSES

OPCAGR 711 - ORGANIC FARMING AND PRECISION AGRICULTURE (2+1)

Learning Objectives

To impart knowledge on the concepts and importance of organic agriculture, precision agriculture and to equip the students with geostatistical techniques and variable crop yield mapping.

THEORY

Unit I - Importance of Organic farming

Organic farming – current status of organic farming in India and Tamil Nadu – Potential resources for nutrient supply in organic farming – Prospects and limitations of organic farming in field and horticultural crops - ITK in organic agriculture

Unit II - Soil health and organic certification

Organic farming in relation to soil health and quality organic farming in relation to insect and disease management – organic manures, bio-fertilizers, blue green algae and vermicompost in organic farming - Trade, industry and certification in organic farming – certification standards - Procedures and regulatory mechanisms in organic agriculture – Government policies towards research and development of organic farming in India.

Unit III - Precision farming

Precision farming – concept and approach – Application of precision concept in INM of field crops – Land information for precision agriculture – Remote sensing – GIS and GPS – VAT based precision farming. Scope of precision farming in agriculture, horticulture and plantation crops.

Unit IV - Yield mapping techniques

Potential and limitation of satellite remote sensing in precision agriculture – yield mapping with remote sensing for precision agriculture – precise water management in agriculture using spatial hydrological methods and remote sensing – use of hyperspectral data for precision farming – soil survey and mapping techniques for precision farming.

Unit V - Application of GIS and decision support system tool

GIS based nutrient delivery systems – Development of sensors and their evaluation – remote sensing and GIS applications for management of land and water resources on watershed framework – Decision support system tool for impact assessment of saline and sodic environment – geo-statistical techniques for precision farming – Spatial and temporal variability of soil physical parameters – DSSAT for variable crop yield mapping – Farm machinery for precise input application. **Current stream of thoughts in organic Agriculture.**

PRACTICAL

Aerobic and anaerobic methods of making compost, making vermicompost – Efficient use of biofertilizers – techniques of treating legume seeds with Rhizobium cultures, use of Azotobacter, Azospirillum, and PSB cultures in field - Visit to an organic farm – bio – dynamic farm – Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms. Visual image interpretation, Spectral Indices, Thermal indices derived from remote sensing data, Spectroradiometer data analysis, IR thermometer principles and working, Map projection system. Digital image processing, ERDAS imaging, ARC view, Satellites, Sensors and platforms, Satellite data acquisition and dissemination, Principles of crop modeling.

THEORY LECTURE SCHEDULE

1. Organic Farming – definition, concepts, prospects, opportunities and priorities.
2. Current status of Organic Farming in India and Tamil Nadu.
3. Resources for nutrient supply in organic farming – Bio and industrial wastes.
4. Role of Indigenous technological knowledge (ITK) in organic agriculture.
5. Prospects and limitations of organic farming in field crops – Cereals, millets, and pulses.
6. Prospects and limitations of organic farming in field crops – Oilseeds and commercial crops.
7. Prospects of organic farming in agriculture and horticultural crops – Vegetables, fruits, spices and plantation crops.
8. Organic farming in relation to soil health and quality.
9. Organic farming in relation to insect and disease management.

10. Organic manures, bio-fertilizers, blue green algae and vermicompost for organic farming.
11. Government policies towards development of organic farming in India.
12. Trade, industry and certification in organic farming - Certification standards, procedures and regulatory mechanisms.
13. Precision farming - concept, approach and relevance to Indian Agriculture.
14. Application of precision concept in INM of field crops.
15. Precision agriculture and cropping system.
16. Soil and land information of precision agriculture.
17. **Mid Semester Examination.**
18. Remote sensing - GIS and GPS - VAT based precision farming.
19. Scope of precision farming in horticulture / plantation crops.
20. Potential and limitation of satellite remote sensing for precision farming.
21. Yield mapping with remote sensing for precision agriculture.
22. Precise water management in agriculture using spatial hydrological models and remote sensing.
23. Use of hyperspectral data for precision farming.
24. Soil survey and mapping techniques for precision farming.
25. GIS based nutrient delivery systems.
26. Development of sensors and their evaluation.
27. Remote sensing and GIS applications for management of land and water resources on watershed framework.
28. Decision support system tool for impact assessment of saline/sodic environment.
29. Geostatistical techniques for precision farming.
30. Spatial and temporal variability of soil physical parameters.
31. DSSAT for variable crop yield mapping.
32. Farm machinery for precise input application.
33. Precision farming in agroforestry.
34. Weather forecast - A decision tool for precision farming.

PRACTICAL SCHEDULE

1. Practicing aerobic methods of making compost.
2. Practicing anaerobic methods of making compost.
3. Practicing vermicomposting methods.
4. Techniques of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum* and PSB cultures in field.
5. Role of Indigenous Technological Knowledge (ITK) in weed, insect and disease management.
6. Visit to sugar industry to study the by-products composting.
7. Visit to an organic farm.
8. Visit to biodynamic farm.
9. Quality standards, inspection, certification and labelling and accreditation procedures for farm produce from organic farms.
10. Visual image interpretation, spectral indices, thermal indices derived from remote sensing data.
11. Spectro radiometer data analysis.
12. Study of IR thermometer principles and working.
13. Practicing map projection system.
14. Practicing digital image processing.
15. ERDAS imaging, ARC view, satellites.
16. Study of sensors and platforms.
17. Satellite data acquisition and dissemination and crop modeling studies.

Course Outcomes

CO 1: To acquire knowledge on concepts of organic agriculture.

CO 2: To gain the information about the impact of organic farming and indigenous practices on environment.

CO 3: To understand the procedure followed for organic certification as per NPOP guidelines namely production standards, labelling and accreditation.

CO 4: To equip students with geostatistical techniques and variables of crop yield mapping.

CO 5: To understand GIS based nutrient delivery system and DSSAT for variable crop yield mapping.

CO-PO Mapping - with POs of Agricultural Entomology

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

References

1. Ananda Srinivasan. 2006. *Hand book of precision agriculture principles and applications*. The Howonh prem. Binghamton. Ny.USA.
2. Ananthkrishnan, T.N. (editor), 1992. *Emerging trends in biological control of phytophagous insects*, Oxford & IBH, New Delhi.
3. Anji Reddy, M., 2003. *Text book of remote sensing and GIS* B.S. Publications, Hyderabad.
4. Dushyent Gen lot. 2009. *Organic farming, standards accreditation certification and inspection*. Agrobios (INDIA), Jodhpur.
5. Lampin, N., 1990. *Organic farming*, Press Books Ipswithc, U.K.
6. Lilleasand, T.M., and Kiefer, R.W. 1994. *Remote sensing and image interpretation*, John Wiley and sons. Inc. New York. 750p.
7. Palaniappan, SP., and Annadurai, K.1999. *Organic farming theory and practice*. Scientific Pub., Jodhpur.
8. Panwar, JOS and Amet kumar Jash. 2016. *Organic farming scope and use of biofertilizers*, New India Publishing agency, New Delhi.
9. Ram Swanoop Meena and Vivendra Kamal Vanshi. 2015. *The DBS Hand book of organic farming*. DBS Imprents, New Delhi.
10. Reddy. M.V. (Ed.), 1995. *Soil organism and litter decomposition in the tropics*, Oxford and IBH, New Delhi.
11. Singh A.K, 2015. *Organic farming*, New India publishing agency, New Delhi. Singh, SP. (Ed.), 1994. *Technology for Production of Natural Enemies*, Project Directorate of Biological control, Bangalore
12. Veeresh, G.K., K. Shivashankar, and Suiglacher, M.A. 1997. *Organic farming and sustainable agriculture*, Association for Promotion of Organic Farming, Bangalore.
13. Woomer, P.L., and Swif, M.J. 1994. *The Biological Management of Tropical Soil Fertility*, T.S.B.F. and Wiley.

e-Resources

1. http://ncof.dacnet.nic.in/Training_manuals/Training_manuals_in_English/Organic_Agriculture_in_India.pdf

2. http://orgprints.org/2768/1/eyhorn-2004-Organic_Agriculture_in_India.pdf
3. <http://www.fao.org/organicag/oa-home/en/>
4. <https://www.fibl.org/fileadmin/documents/shop/1636-organic-world-2014.pdf>

OPCAGR 712 - DRY FARMING AND WATERSHED MANAGEMENT (2+1)

Learning Objective

To impart scientific knowledge on concepts and practices of dry farming, soil moisture conservation and watershed management.

THEORY

Unit I - Principles of dry land agriculture

Dry farming-Definition, concept, characteristics and classification-Significance and dimensions of dry farming in Indian agriculture-Production constraints in dry farming areas - Rainfall characterization in dry lands.

Unit II - Drought and mitigation strategies

Drought and its classification - Drought resistance in crops - Mechanism for drought tolerance and crop adaptability to drought situations - Drought tolerant crops and their varieties, plant ideotypes for dry land areas - ephemerals - shoot and root growth characteristics - preparation of appropriate crop plans for dry land areas - midseason correction for aberrant weather situation - contingent crop planning .

Unit III - Soil moisture conservation techniques in drylands

Soil moisture conservation techniques - Agronomic, Engineering and Biological methods - Moisture retention and availability concepts - Length of Growing Period (LGP) - Water absorption by crop plants under stress conditions - Water loss through evaporation and transpiration and its management under stress conditions - effectiveness and economics - Management of soil constraints.

Unit IV - Approaches for Integrated dry farming technology

Agricultural implements and machineries for dry farming - Tillage - Soil and crop management techniques: seed hardening and efficient fertilizer use - Integrated dry farming technology - Cropping systems, integrated farming systems, organic farming and alternative land use systems.

Unit V - Watershed management

Watershed management - concepts, approaches and components - Water harvesting techniques - Scope and application - Rain water management in watershed - pre and post sowing conservation technologies - Role of organization in promoting watershed - Selection of crops and cropping systems based on rainfall and socio - economic factors - Land capability classification - Rehabilitation of degraded lands in watershed . **Current stream of thoughts in dry farming and watershed.**

PRACTICAL

Mapping of arid and semiarid zones of India and agro - climatic zones of India and Tamil Nadu - study of moisture profiles of soils - Rainfall analysis and interpretation - Use of mulches and antitranspirants - seed hardening techniques - germination and crop establishment in relation to moisture stress - Estimation of moisture index, aridity index and Water-Use Efficiency - Plant root growth studies with reference to stress management - farm mechanization in dry farming - Collection and interpretation of data for water balance equations - Estimation of run-off and soil moisture loss - Crop planning for different drought conditions - Preparation of model watershed programme - Visit to dry farming research experiments / exposure visits to research institutes/ stations and watersheds.

THEORY LECTURE SCHEDULE

1. Dry farming- Definition, concept, characteristics.
2. Dimensions of dry land farming in Indian agriculture.
3. Dry farming- classification - significance and dimensions of dry farming in India.

4. Production constraints in dry farming areas.
5. Rainfall characterization and behaviours.
6. Delineation of dry farming areas on the basis of drought indices and their characteristics.
7. Drought and its classification.
8. Drought management strategies and preparation of crop plans for dry land areas.
9. Dry land crop production technologies for sustainable agriculture.
10. Methods of controlling runoff and its significance.
11. Evaporation, evapo-transpiration, mulching, antitranspirants and antievaporants.
12. Drought resistance in crops - Mechanism for drought tolerance and crop adaptability to drought situations.
13. Drought tolerant crops and their varieties.
14. Plant ideotypes for dryland areas - shoot and root growth characteristics.
15. Preparation of appropriate crop plans for dryland areas.
16. Midseason correction for aberrant weather situation.
17. **Mid-semester examination**
18. Contingent crop planning to mitigate drought.
19. Soil moisture conservation techniques - Agronomic, Engineering and Biological.
20. Moisture retention and availability concepts - Length of Growing Period (LGP) - Water absorption by crop plants under stress conditions.
21. Water loss through evaporation and transpiration and its management under stress conditions - effectiveness and economics- management of soil constraints.
22. Agricultural implements and machineries for dry farming.
23. Tillage - Soil and crop management techniques - seed hardening and efficient fertilizer use.
24. Integrated dry farming technology - Cropping systems.
25. Integrated farming systems - significance - location specific IFS - models for wetlands, garden lands and drylands.
26. Organic farming and alternative land use systems.
27. Watershed management: Definition, concepts, problems, approaches and components of watershed.
28. Problems, approach components, development of cropping systems for watershed areas.
29. Resource management and crop planning - alternate land use pattern
30. Water harvesting techniques - Scope and application - Rain water management in watershed.
31. Pre and post sowing conservation technologies.
32. Role of organization in promoting watershed.
33. Selection of crops and cropping systems based on rainfall and socio economic factors.
34. Classification of land based on LCC and rehabilitation of degraded lands in watershed.

PRACTICAL SCHEDULE

1. Mapping of arid and semiarid zones of Tamilnadu and India.
2. Study of moisture profiles of soils.
3. Rainfall analysis and interpretation.
4. Designing cropping systems based on rainfall analysis
5. Use of mulches and antitranspirants.
6. Seed treatment techniques -hardening, seed priming.
7. Estimation of moisture index, aridity index and water-use efficiency.
8. Plant root growth studies with reference to stress management.

9. Study of farm implements in dry farming.
10. Estimation of run-off and soil moisture loss.
11. Collection and interpretation of data for water balance equations.
12. Preparation and methodology for implementation of watershed projects.
13. Preparation of model watershed programme.
14. Visit to nearby watershed.
15. Visit to dry land agricultural and horticultural research stations.
16. Crop planning for different drought conditions.
17. Assessment of biomass production under watershed area.

Course Outcomes:

CO1: To construct mapping of arid and semi arid regions

CO2: To acquire skill on integrated dry farming technologies

CO3: To gain knowledge on soil and moisture conservation approaches and contingent crop plan to evade risk in dry farming.

CO 4: To formulate IFS model for dry farming region

CO5: To acquire practical knowledge on rain water harvesting techniques and watershed management principles

CO-PO Mapping - with POs of Agricultural Entomology

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

References

1. Das, H.P. 2016. Climate change and agriculture implications for global food security. B.S publications, Hyderabad.
2. Das, NR. 2007. Tillage and crop production. Scientific Publishers, Jodhpur, India
3. Dhopte, A.M. 2002. Agro-technology for dryland farming. Scientific Publishers, Jodhpur, India
4. Dhruv Narayan, VV. 2002. Soil and water conservation research in India. ICAR publications, New Delhi.
5. Gupta, U.S. 1990. Physiological aspects of dry farming. Oxford and IBH Publication, New Delhi.
6. Jeevananda Reddy S. 2002. Dryland agriculture. B.S.Publications, Hyderabad.
7. Kerkar, R.R . 2010. Climate change - A holistic view. B.S publications, Hyderabad
8. Khan, M.A.2002.Watershed management for sustainable agriculture. Agrobios (India) Jodhpur
9. Panda, S.C..2008. Dryland agriculture, Agribios,India, Jodhapur.
10. Rao, SC and Ryan, J. 2007. Challenges and strategies of dryland agriculture. Scientific Publishers, Jodhpur, India.
11. Rao, G.G.S.N.2015. Drought in agricultural production, New India publishing Agency, New Delhi.
12. Singh, P and Maliwal, PL. 2005. Technologies for food security and sustainable agriculture. Agrotech Publishing Company.
13. Singh, RP. 2005. Sustainable development of dryland agriculture in India. Scientific Publishers, Jodhpur, India
14. Venkateshwarlu, J. 2004. Rainfed agriculture in India. Research and Development Scenario. ICAR.

e-Resources

1. www.fao.org/docrep/w7314e/w7314e0q.htm
2. www.ias.ac.in
3. www.wcainfonet.org/.../soilmoistureconservtion_en_1303_all_1.html
4. www.world-agriculture.com

OPCENT 711 PRODUCTIVE INSECTS AND WEED KILLERS (2+1)

Learning objectives

- To impart knowledge on the basic and commercial aspects of productive insects such as honeybee, silkworm and minor productive insects.
- To know the importance of weed killers.

THEORY

Unit I: Basics of Apiculture

History of bee keeping in India - Honey bee species - Colony organization of honey bees - Bee behavior. Apiary establishment - Bee pasturage. Floral calendar - Colony management. Bee keeping appliances. Artificial queen rearing. Pests and Diseases of honey bee and their management. Modern techniques of bee keeping - Collapsible hives or flow hives, hex hives, etc.- impact of pesticides on honey bees.

Unit II: Specialized beekeeping methods and bee products

Specialized bee keeping methods -Organic or natural bee keeping, Migratory bee keeping, Urban bee keeping. Bee hive products - Bee wax - Extraction techniques - Bee venom and its products - Apitherapy - Propolis, Royal jelly - Collection, Uses and marketing of bee products. Bee keeping and ancillary industries. SWOT analysis. Quality standards of honey - Skill development in apiculture.

Unit III: Moriculture

Importance of mulberry cultivation in sericulture - Characteristics of mulberry varieties/ hybrids - Mulberry cultivation - Propagation -Asexual and sexual - Methods of planting - Nursery and field preparation - soil, water and nutrient management - Pruning methods - Pests and diseases of mulberry and their management. Preservation of leaves - Nutrient value of mulberry and its uses. Value added products of mulberry. Cultivation of host plants of non- mulberry silkworm.

Unit IV: Sericulture and minor productive insects

History of sericulture in India - Types of silkworm - Races of silkworm -Grainage technology - rearing house maintenance -- rearing equipments, disinfectants - Chawki and Late age rearing. Pests and diseases of silkworm and their management. Mountages - harvesting of cocoons. Non -mulberry silkworms. Silk processing and marketing. Diversification of seriproducs - Uses - e-commerce - Entrepreneurial development. Seri biotechnology - prospects and progress. SWOT analysis of sericulture - Skill development in sericulture - Minor productive insects.

Unit V: Biological control of weeds using insects

Weed - definition -Noxious and invasive weeds - Importance - basic classification - Biological control of weeds - Role of insects - Definitions - Principles of biological control of weeds using insects -Conservation and augmentation techniques for weed killers - examples in India and other parts of the world - Benefits and risks - Damage to non-target plants - Future prospects. **Current stream of thoughts in productive insects.**

PRACTICALS

Identification of different species of honey bees, castes of bees. Bee keeping appliances. Handling of bees, practicing inspection of bee hives and Queen rearing techniques. Identification of pests and non-insect pests of bees and diagnosis of bacterial, viral, fungal and protozoan diseases. Apiary management techniques during on-season and dearth period. Identification of different value added bee products. Honey testing kits, testing the quality of honey using standard protocols – Economics of bee keeping.

Identification of different types of silkworms – Identification of different varieties and hybrids of mulberry – Practicing different propagation techniques and planting methods- Mulberry production techniques –Nursery management – Practicing different pruning methods - Silkworm egg production – Chawki and late age rearing – Silkworm rearing equipments - Identification of insect, non insect pests and diseases of silkworms – Prevention – Management techniques – Sericlinic – Utilization of sericulture waste – Diversification of mulberry and sericulture products – Economics of Moriculture and Sericulture – non mulberry silkworms – Minor productive insects. Identification of important weed killers – Evaluation of feeding potential of weed killers – Mass production techniques of potential weed killer insects.

THEORY LECTURE SCHEDULE

1. History of bee keeping in India – Honey bee species.
2. Colony organization of Honey bees and Bee behavior.
3. Apiary establishment – Bee Pasturage. – Floral Calendar.
4. Colony management – Bee keeping appliances.
5. Artificial queen rearing – Pests and Diseases of honey bee and their management.
6. Modern techniques of bee keeping –Collapsible hives or Flow hives, Hex hives etc.,
7. Scope of biotechnology in Apiculture and impact of pesticides on honey bees.
8. Organic or Natural bee keeping, Migratory bee keeping and Urban bee keeping.
9. Bee wax – Extraction techniques – Bee venom and its products – Apitherapy.
10. Propolis, Royal jelly – Collection – Uses and Marketing of bee products.
11. Bee keeping and ancillary industries.
12. SWOT analysis of bee keeping.
13. Quality standard of honey.
14. Skill development in apiculture.
15. Importance of mulberry cultivation in sericulture and characteristics of mulberry varieties/ hybrids.
16. Asexual and sexual propagation of Mulberry.
17. **Mid semester examination**
18. Methods of planting. Nursery and field preparation – soil, water and nutrient management.
19. Pruning methods – Pests and Diseases of mulberry and their management.
20. Preservation of leaves – Nutrient value of mulberry and its uses. Value added products of mulberry.
21. Cultivation of host plants of non- mulberry silkworm.
22. History of sericulture in India – Types of silkworm – Races of silkworm and Grainage technology.
23. Rearing house maintenance and rearing equipments, disinfectants.

24. Chawki and Late age rearing. Mountages -harvesting of cocoons.
25. Pests and Diseases of silkworm and their management.
26. Non -mulberry silkworms.
27. Silk processing and Marketing. Seri biotechnology - prospects and progress.
28. Diversification of seriproducs - Uses - e- commerce - Entrepreneurial development - SWOT analysis of sericulture.
29. Skill development in sericulture.
30. Minor productive insects.
31. Weed - definition -Noxious and invasive weeds - Importance - basic classification - Biological control of weeds - Role of insects.
32. Principles of biological control of weeds using insects.
33. Conservation and augmentation techniques for weed killers - Examples in India and other parts of the world.
34. Benefits and Risks involved - Damage to Non-Target plants - Future prospects.

PRACTICAL SCHEDULE

1. Identification of different species of honey bees, castes of bees.
2. Handling of bee keeping appliances.
3. Handling of bees, practicing of hive inspection, apiary management and Queen bee rearing techniques.
4. Identification of pests and non insect pests of bees and diagnosis of bacterial, viral, fungal and protozoan diseases.
5. Identification of different value added bee products. Testing the quality of honey using standard protocols. Economics of bee keeping.
6. Identification of different types of silkworms - Identification of different varieties and hybrids of mulberry - Practicing different propagation techniques and planting methods.
7. Nursery management - Practicing different pruning methods.
8. Silkworm egg production - Chawki and late age rearing.
9. Silkworm rearing equipments.
10. Identification of insect and non insect pests and diseases of silkworms - Prevention - Management techniques.
11. Sericlinic - Utilization of sericulture waste. Diversification of mulberry and sericulture products.
12. Economics of Moriculture and Sericulture.
13. Non mulberry silkworms.
14. Minor productive insects.
15. Identification of important weed killers.
16. Evaluation of feeding potential of weed killers.
17. Mass production techniques for potential weed killer insects.

Course Outcomes

CO1: Capable of identifying the honey bee species, Learn about beekeeping tool And equipment and Apiary management techniques

CO2: Describe bee keeping methods, Migratory bee keeping and Economics of Bee keeping

CO3: Practice mulberry plant cultivation and produce good quality of leaf for

cocoon production

CO4 : Demonstrate rearing method of mulberry and non mulberry Silkworm and uses minor productive insects .

CO5 : Capable of identifying the Identification of important weed killers, Mass production techniques of potential weed killer insects and Conservation and augmentation techniques for weed killers

References:

1. Abrol, D.P. 2016. *Bees and Beekeeping in India*, Kalyani Publications, Ludhiana, 719 p.
2. Dandin, S.B. and J. Jayaswal. 2013. *Handbook of Sericulture Technologies*, Central Silk Board, Bangalore, 324 p.
3. Ganga, G. and S. Reddy. 2017. *An Introduction to Sericulture*, Oxford and IBH Publishers, New Delhi, 426 p.
4. Hariprasad, Y. and S. Manickavasagam. 2012. *Essentials of Apiculture*, Sarguna Printers, Chidambaram, 120 p.
5. Jayanth.K.P. 2000. Biological Control of Weeds in India. In: Upadhyay R., K.G. Mukerji and B.P. Chambala (eds) *Biocontrol Potential and its Exploitation in Sustainable Agriculture*. Springer, Boston, pp. 207-221.
6. Misra,R.C. 2012. *Perspectives in Indian Apiculture*, Agro Botanica, Bikaner, 311 p.
7. Rabindra, J. S. Basavaraj and S. Bhumannavar. 2009. Biological Control of Weeds in India, In: Muniappan, R., G.Reddy and A.Raman (Eds), *Biological control of tropical weeds using Arthropods*,Cambridge University Press, UK, pp. 438 -452.
8. Rahman, A. 2017. *Apiculture in India*, Jain Publishing House, New Delhi, 265 p.
9. Sathe,T.V.2014.*Fundamentals of Beekeeping*, Daya Publishing House. New Delhi, 375 p.
10. Vasantharaj David. B. and V.V. Ramamoorthy. 2016. *Elements of Economic Entomology*, Brillion Publishers, New Delhi, 625 p.

E-resources

1. <http://nbb.gov.in/aboutus.htm>
2. <http://kvic.org.in/kvicres/honeymission.htm>
3. <http://www.csrtimys.res.in/books-0>
4. <http://www.csb.gov.in/publications/books/>
5. file:///E:/10_459-467.pdf
6. <https://pdfs.semanticscholar.org/e6e4/639906ee0dff3554212acd6d040712221d72.pdf>

OPCENT 712 PEST MANAGEMENT IN ORGANIC FARMING (2+1)

Learning objectives

- To understand the importance and scope of pest management in organic farming.
- To acquaint with various strategies in organic pest management
- To understand various input certification standards

THEORY

Unit I: Importance of organic farming

Organic farming – Definition – Current status, scope and importance. History of organic farming – Agencies and schemes in relation to organic farming. Importance of pest management in organic farming – Components of pest management strategies in organic

farming – Cultural, biological, botanical, behavioural and ecological engineering strategies – Definition.

Unit II: Cultural and traditional strategies

Cultural practices – Importance – Principles – Role of crop rotation, crop isolation, soil management, crop residue management, weed management, field localization, tillage. Host plant resistance – Traditional varieties of major crops. Pest evasion through temporal isolation of crops. Successful examples – limitations. Traditional methods of pest management – Traditional storage structures – Rodent management.

Unit III: Ecological engineering strategies

Ecological engineering – Importance. Role of conservation of natural enemies in pest management – Beetle bank – Weed strips – Pollen producing ground cover – Cropping systems – Trap and intercropping – Push – Pull strategy – successful examples – limitations. Importance of community approach in implementation of ecological engineering.

Unit IV: Biological, botanical and behavioural strategies

Entomophages and entomopathogens in organic pest control – Different types. General principles of mass production. Application of bacterial, viral, myco insecticides and entomophages – Role of insectivorous birds in pest management – Importance of insecticides of plant origin – Plant extracts and their preparation – application – Shelf life and storage – Use of pheromones and other traps in pest management – Importance.

Unit V: Permitted pest management inputs

Organic certification Standards – NPOP, NOP, JAS, and European standards – Permitted inputs for pest management under various standards with emphasis on NPOP – APEDA – Certification agencies – Input approval criteria – Current status of organic pest management inputs in the market – Marketing and scope of certified organic inputs. **Current stream of thoughts in pest management in organic farming.**

PRACTICALS

Introduction to pests and basic principles of pest management excluding chemicals – Various cultural practices for pest management – Studying characters of resistant varieties of important crops – Agro ecosystem survey analysis – Study of various inter cropping and trap cropping systems – Identification of refugia crops in important crop ecosystems and traditional pest management methods – Practicing conservation techniques of natural enemies – Identification of important entomopathogens, predators, parasitoids and insectivorous birds by their common names – Brief mass production procedure for green lace wings, Coccinellids, *Trichogramma* – Brief mass production procedure for NPV, mycoinsecticides and Bt – Identification of plants used as insecticides- Preparation of popular botanical insecticides, their application – Traps and pheromones in organic pest management – Studying organic certification standards – Market analysis of certified organic inputs – visit to organic farms practicing pest management.

THEORY LECTURE SCHEDULE

1. Organic farming – Definition – Current status, scope and importance.
2. History of organic farming.
3. Agencies and schemes in relation to organic farming.
4. Importance of pest management in organic farming.

5. Components of pest management strategies for organic crops – Cultural, biological, botanical, behavioural and ecological engineering strategies – Definition.
6. Cultural practices – Importance – Principles.
7. Role of crop rotation, crop isolation and soil management.
8. Role of crop residue management, weed management, field localization, tillage.
9. Host plant resistance – Traditional varieties of major crops.
10. Pest evasion through temporal isolation of crops. Successful examples – limitations.
11. Advantages and disadvantages of cultural practices.
12. Traditional methods of pest management – traditional storage structures
13. Rodent management.
14. Ecological engineering - Definition and importance.
15. Role of conservation of natural enemies in pest management – Beetle bank -Weed strips – Pollen producing ground cover.
16. Cropping systems – Trap and intercropping.
- 17. Mid semester examination.**
18. Push – Pull strategy – successful examples – limitations.
19. Importance of community approach in implementation of ecological engineering.
20. Entomophages and entomopathogens in organic pest control –Different types.
21. General principles of mass production.
22. Application of bacterial, viral and myco insecticides.
23. Application of entomophages.
24. Role of insectivorous birds in pest management.
25. Importance of insecticides of plant origin – Examples.
26. Plant extracts and their preparation.
27. Plant extracts application, Shelf life and storage.
28. Use of pheromones and other traps in pest management – Importance.
29. Organic certification Standards – NPOP, NOP, JAS, and European standards.
30. Permitted inputs for pest management under various standards with emphasis on NPOP.
31. APEDA - Certification agencies.
32. Organic input approval criteria.
33. Current status of organic pest management inputs in the market.
34. Marketing and scope of certified organic inputs.

PRACTICAL SCHEDULE

1. Introduction to pests and basic principles of pest management excluding chemicals.
2. Practicing various cultural practices for pest management.
3. Studying characters of resistant varieties of important crops.
4. Agro ecosystem survey analysis.
5. Study of various inter cropping and trap cropping systems.
6. Identification of refugia crops in important crop ecosystems.
7. Studying traditional pest management methods.
8. Practicing conservation techniques of natural enemies.
9. Identification of important entomopathogens, predators, parasitoids and insectivorous birds by their common names.

10. Brief mass production procedure for green lace wings, Coccinellids and *Trichogramma*.
11. Brief mass production procedure for NPV and mycoinsecticides.
12. Brief mass production procedure of *Bt*.
13. Identification of plants used as insecticides.
14. Preparation of popular botanical insecticides, their application.
15. Traps and pheromones in organic pest management.
16. Studying organic certification standards and Market analysis of certified organic inputs.
17. Visit to organic farms.

Course Outcomes

CO1: Understands the scope and importance of organic farming and pest management related challenges in organic farming

CO2: Describe cultural and traditional pest management activities and their impact

CO3: Demonstrate ecological engineering tactics in conservation, augmentation Of natural enemies and deterrence of pests

CO4: Explain bio rational pest management options for organic pest Management

CO5: Discuss the legislation, certification and agencies involved in organic certification process.

References:

1. Altieri, M.A., C.I. Nicholls and M.A. Fritz. 2014. *Manage insects on your farm - A Guide to Ecological Strategies*, Sustainable Agriculture Research and Education (SARE) College Park, Maryland, USA, 146 p.
2. Directorate of Plant Protection, Quarantine and Storage. 2014. *Standard Operating Procedures (SOP) for Integrated Pest Management (IPM) - Technical manual*, Directorate of Plant Protection, Quarantine and Storage, 144 p.
3. Gurr, G.M., S.D. Wratten and M.A. Altieri. 2004. *Ecological Engineering for Pest Management: Habitat Manipulation for Arthropods*, CSIRO Publishing, Collingwood, Australia. 238 p.
4. Gurr, G.M., S.D. Wratten and W.E. Snyder. 2012. *Bio diversity and insect pests: Key issues for Sustainable Management*, Wiley – Blackwell, USA, 360 p.
5. Khetan, S.K. 2005. *Microbial Pest Control*, Marcel Dekker, New York, 320 p.
6. Mahr, D.L., P. Whitaker and N. Ridgway. 2007. *Biological Control of Insect Pests and Mites*, University of Wisconsin, USA, 120 p.
7. Radcliffe, E.B., W.B. Hutchison and R.E. Cancelado. 2009. *Integrated Pest Management Concepts, Tactics, Strategies and Case Studies*, Cambridge University Press, UK. 529 p.
8. Vacante, V. and S. Kreiter. 2017. *Handbook of Pest Management in Organic Farming*, CABI, London, 576 p.
9. Yadav, A.K. 2005. *Training Manual on Certification and Inspection Systems in Organic Farming in India*, National Centre of Organic Farming, Ghaziabad, 45 p.

E-resources

1. APEDA. 2005. Certification manual - NPOP 2005.
http://www.apeda.gov.in/apedawebiste/organic/organic_contents/english_organic_sept05.pdf
2. <https://www.sare.org/Learning-Center/Topic-Rooms/Organic-Production/Organic-Pest-Management>
3. <http://bit.ly/ipmwebinars>

4. <http://ageconsearch.umn.edu/bitstream/120916/2/GurrWrattenAltieri02.pdf>
5. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2610173/>

OPC PAT 711 BIOLOGICAL CONTROL OF CROP DISEASES (2+1)

Learning Objective

To study the principles and application of eco-friendly and sustainable biological management strategies of plant diseases.

THEORY

Unit -I History and importance

Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.

Unit - II Mechanisms of biocontrol agents

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

Unit - III Compatibility and management strategies of plant pathogens

Factors governing biological control, role of physical environment, agro ecosystem, operational mechanisms and cultural practices in biological control of pathogens, pathogens and antagonists and their relationship. Comparative approaches to biological control of plant pathogens by resident and introduced antagonists, management of soil-borne, seed borne and foliar diseases. Compatibility of different bioagents.

Unit - IV Mass multiplication and quality control

Commercial production of antagonists, their delivery systems, application and monitoring of biocontrol agents. Biopesticides available in market. Quality control system of biocontrol agents.

Unit - V Cross protection and botanicals

Pre-immunization technique, hypovirulence. Plant extracts, essential oils, antiviral principles. Mycoherbicides, entomophagus fungus. Antagonist fortified manure. **Current stream of thoughts in crop disease management.**

THEORY SCHEDULE

1. Introduction to biological control of plant diseases, Biocontrol: concept and definitions.
2. History of Biological control of crop diseases, principles of plant disease management with bioagents.
3. Merits and demerits of biological control of plant diseases.
4. Mechanisms of disease control by biocontrol agents.
5. Mechanisms of disease control by biocontrol agents.
6. Hypovirulence-Its role in disease management.
7. Competitive saprophytic ability and rhizosphere colonization.
8. Induced systemic resistance and its role in plant disease resistance.
9. Mycorrhizal associations-VAM- Its operational mechanisms in plant disease management.
10. Factors governing biological control.
11. Role of environment in the biological control of plant diseases.
12. Comparative approaches to biological control of plant pathogens by resident and introduced antagonists.
13. Comparative approaches to biological control of plant pathogens by resident and introduced antagonists.

14. Biological control of soil-borne diseases.
15. Biological control of seed borne and foliar diseases.
16. Compatibility of different biocontrol agents.
17. **Mid-semester Examination.**
18. Isolation of *Trichoderma* spp. and *Pseudomonas* spp. from soil.
19. Mass production of fungal and bacterial biocontrol agents.
20. Mass production of VAM.
21. Precaution in the formulation of biocontrol agents.
22. Delivery systems of biocontrol agents.
23. Assessment of survival of biocontrol agents.
24. Significance of PGPR.
25. Mechanisms of disease control by fungal and bacterial biocontrol agents.
26. Induction of defense enzymes in plants by application of biocontrol agents.
27. Quality control systems of bioformulations.
28. Biopesticides available in the market.
29. Commercial aspects of mass production of biocontrol agents.
30. Commercial aspects of mass production of VAM.
31. Pre-immunization technique.
32. Role of plant extracts in plant disease management.
33. Mycoherbicides and entomophagus fungus.
34. Antagonist enriched farmyard manure.

PRACTICAL

Isolation, characterization and maintenance of antagonists, methods of study of antagonism and antibiosis, defense enzymes, application of antagonists against pathogen *in vitro* and *in vivo* conditions. Mass multiplication, commercial formulation and Study of cfu/g. Cross protection, preparation and application of plant extracts, isolation and formulation of mycoherbicides, entomophagus fungus.

PRACTICAL SCHEDULE

1. Introduction to biological control of plant diseases.
2. Isolation and molecular characterization of biocontrol agents.
3. Isolation of VAM.
4. Testing the antagonistic efficacy of fungal and bacteria antagonists.
5. Testing the compatibility among the biocontrol agents.
6. Methods of application of biocontrol agents.
7. Antibiotic production of biocontrol agents.
8. Estimation of defense enzymes in plants by application of biocontrol agents.
9. Management of microbial contaminants.
10. Fermentation technology and formulation development.
11. Methods of quality control tests.
12. Packing and storage of biocontrol formulations.
13. Cross protection technique.
14. Preparation and application of plant extracts in plant disease management.
15. Application of mycoherbicides and entomophagus fungus.
16. Preparation of antagonist enriched farmyard manure.
17. Visit to Commercial biocontrol units.

Course Outcomes

- 1. Having updated knowledge of new bio regulators.**
- 2. Having knowledge about the mechanism of Bio control agents.**
- 3. Having knowledge, the Hypovirulence, suppressive soil and compatibility of Bio control agents.**

4. **Trained in mass production and quality control methods of Bio control agents.**
5. **Expertise in cross protection techniques and botanical approaches for plant disease management.**

CO-PO Mapping -with POs of Agricultural Entomology

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

Reference

1. Campbell, R. 1989. Biological Control of Microbial Plant Pathogens. Cambridge University Press.
2. Chincholkar and Mukerji, K.G. 2007. Biological Control of Plant Diseases. Oxford and Imprint of Haworth Press.
3. Cook R.J. and Baker, K.F. 1983. Nature and Practice of Biological Control of Plant Pathogens. APS Press.
4. Fokkema, M.J. 1986. Microbiology of the Phyllosphere. Cambridge University Press.
5. Gnanamanickam, S.S. 2002. Biological Control of Crop Diseases. CRC Press.
6. Gnanamanickam, S.S. 2009. Biological Control of Rice Diseases. Springer Publications.
7. Heikki, M.T. and James, M. 1996. Biological Control Benefits and Risks. Cambridge University Press.
8. Narayanasamy, P. 2015. Biological Management of Diseases of Crops. Vol.1. Characteristics of Biological Control Agents. Springer Publications.
9. Narayanasamy, P. 2015. Biological Management of Diseases of Crops. Vol.2. Integration of Biological Control Strategies with Crop Disease Management Systems. Springer Publications.
10. Pratibha Sharma 2014. Biological Control of Plant Diseases and Weeds. ICAR Publications.

e-References

1. <https://www.apsnet.org/edcenter/advanced/topics/Pages/BiologicalControl.aspx>
2. [https://www.apsnet.org/Publications/Brown_Ogle/27%20Control-biological%20\(AMS&GRS\).pdf](https://www.apsnet.org/Publications/Brown_Ogle/27%20Control-biological%20(AMS&GRS).pdf)
3. <http://handelsmanlab.sites.yale.edu/sites/default/files/Future%20trends%r20in%200biocontrol.pdf>
4. <http://www.arc.agric.za/arc-ppri/Leaflets%20Library/Principles%20of%20biological%20control.pdf>
5. teca.fao.org/read/8372

Journals

Biocontrol
Biocontrol Science and Technology

OPC PAT 712 MUSHROOM TECHNOLOGY (2+1)

Learning Objectives

To study the various techniques involved in cultivation, maintenance, cropping pattern, harvest, problems due to pest and diseases and its management and also nutritional value and preservation of edible mushroom

THEORY

Unit- I Importance of Mushroom

Mushroom science: Importance, related fields and their contribution –Global production – Morphology and life cycle: *Pleurotus*, *Calocybe*, *Agaricus*, *Lentinus* and *Volvariella*. Morphogenesis in mushrooms –Role of enzymes in mycelium and basidioma development; physiology of fruiting body development; poisonous mushrooms and mushroom poisoning.

Unit - II Breeding and techniques

Genetics and breeding of cultivated mushrooms: homothallism and heterothallism, primary and secondary mycelium, parasexuality, homokaryotic fruiting. Approaches to breeding: Selection, mutation and hybridization – Tissue culture, single and multispore isolates – Biotechnological methods for strain improvement; study of strain variability using markers – Allozyme, RFLP, AFLP, RAPD and PCR –Laboratory techniques, equipments, culture media, sterilization, pure culture techniques – Preservation of cultures. Spawn types: mother spawn and bed spawn.

Unit - III Production and constraints

Cultivation: oyster mushroom, milky mushroom, paddy straw mushroom, button mushroom and other edible mushrooms – Outdoor cultivation – Ectomycorrhizal mushrooms. Problems in cultivation: weed moulds, diseases, pests and abiotic disorders.

Unit - IV Mushroom usage

Uses of mushroom as food, nutritional and pharmaceutical values. Post-harvest technology: Methods of preservation and value addition. Mushroom recipes: Cooking methods, value added products, pickling, sauce, ketchup and chutney, instant food mixes, extruded and bakery products, quality and sensory evaluation.

Unit - V Cost- Benefit ratio

Cost analysis and project preparation: Principles of enterprise management, preparation of projects, project analysis and financial management – Market survey, export procedures. Agricultural finance: Sources of finance and acquisition. **Current stream of thoughts in mushroom technology.**

PRACTICAL

Introduction to mushroom – Edible and poisonous type – Edible mushrooms: *Pleurotus*, *Agaricus*, *Volvariella*, *Lentinus* and *Calocybe* –Preparation of culture media – Pure culture techniques – Sterilizing techniques – Media – Maintenance of culture – Mother spawn production – Type of spawn – Polybag method – Multiplication of spawn mushroom cultivation techniques – Maintenance of spawn running and cropping room – Harvest – Packing and storage of mushroom – Problems in cultivation: pests, diseases and weed moulds, management strategies – Nutritional value – Post-harvest technology – Methods of preservation – Other uses of mushroom – Cost analysis and project preparation.

THEORY LECTURE SCHEDULE

1. Introduction to Mushroom technology.
2. Morphology and life cycle of *Pleurotus* and *Calocybe*.
3. Morphology and life cycle of *Agaricus*, *Lentinus* and *Volvariella*.
4. Role of enzymes in mycelium and basidioma development.
5. Role of amylolytic enzymes in mushroom morphogenesis.
6. The physiology of fruiting body development.
7. Poisonous mushrooms.
8. Genetics and breeding of cultivated mushrooms.
9. Biotechnological methods for strain improvement.
10. Study of strain variability using markers: Allozyme, RFLP, AFLP, RAPD and PCR.

11. Laboratory techniques, preservation of cultures.
12. Spawn types, mother spawn and bed spawn.
13. Cultivation of oyster mushroom.
14. Cultivation of milky mushroom.
15. Cultivation of paddy straw mushroom.
16. Cultivation of button mushroom.
17. **Mid-semester Examination.**
18. Cultivation of shiitake mushroom
19. Outdoor visit.
20. Ectomycorrhizal mushroom.
21. Problems in cultivation: weeds and diseases.
22. Problems in cultivation: pests and abiotic disorder.
23. Uses of mushroom as food (nutritional value).
24. Uses of mushrooms as medicine.
25. Post-harvest technology, method of preservation and value addition
26. Mushrooms recipes.
27. Cost analysis in mushroom production.
28. Project preparation.
29. Project preparation.
30. Principles of enterprise management.
31. Market survey.
32. Export procedures.
33. Agricultural finance: source of finance and acquisition.

PRACTICAL SCHEDULE

1. Introduction to mushrooms.
2. Preparation of culture media.
3. Collection, identification and pure culturing of mushrooms.
4. Collection, identification and pure culturing of mushrooms.
5. Strain improvement method: single spore isolation, hyphal anastomosis and chemical mutation.
6. Preparation of mother spawn.
7. Preparation of bed spawn.
8. Maintenance of mushroom shed.
9. Cultivation of oyster mushroom.
10. Cultivation of oyster mushroom.
11. Cultivation of milky mushroom.
12. Cultivation of milky mushroom.
13. Harvest, packing and storage of mushroom.
14. Problems in cultivation and its management.
15. Post-harvest technology of mushroom.
16. Cost analysis and project preparation.
17. Visit to Commercial mushroom production units.

References

1. Aneja, K.R. 2018. Experiments in Microbiology, Plant Pathology, Tissue culture and Cultivation of Mushroom, New Age International Publishers.
2. Bahl, N. 2000. Handbook of Mushrooms. Oxford & IBH Publishing Co. Pvt. Ltd.
3. Chadha, K.L. and Sharma, S.R. 1995. Mushroom Biotechnology Advances in Horticulture. Malhotra Publishing House.
4. Chauhan, N.M., Gagre, N.K. and Prajapati, V.P. 2013. Scientific Cultivation of Mushroom. Biotech books.

5. Kannaiyan, S., Marimuthu, T. and Leni, K. 2011. Diversity and Production of Edible Mushrooms. Associated Publishing Company.
6. Krishnamoorthy, A.S., Marimuthu, T. and Nakkeeran, S. 2005. Mushroom Biotechnology, TNAU Press, Coimbatore.
7. Manjit Singh, B., Vijay, B., Kamal, S. and Wakchaure, G.C. 2011. Mushrooms Cultivation, Marketing and Consumption. National Research Centre for Mushroom, Solan.
8. Miles, P.G. and Chang, S.T. 2004. Mushrooms: Cultivation, Nutritional Value, Medicinal Effect and Environmental Impact. CRC Press.
9. Rai, R.D., Upadhyay, R.C. and Sharma, S.R. 2005. Frontiers in Mushroom Biotechnology. National Research Centre for Mushroom, Solan.
10. Suman, B.C. and Sharma, V.P. 2007. Mushroom Cultivation in India. Daya Publishing House.

e-References

1. www.emushroom.net
2. www.mushroomdays.com.cn
3. <https://www.mushroomcouncil.com>
4. <https://fungiforthepeople.org>
5. nrcmushroom.org

Course Outcomes

1. Updated knowledge about new edible and medicinal mushrooms
2. Trained in isolation and identification of mushroom
3. Awareness about the mushroom production constraints
4. Having knowledge about the uses of Mushroom
5. Expertise in cost analysis in mushroom production and project preparation

CO-PO Mapping with POs of Agricultural Entomology

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

OPCAGM 711- MICROBIAL INOCULANT PRODUCTION TECHNOLOGY (2+1)

Learning Objective

To study the basic principles and application methodologies of different microbial inoculants in order to improve the soil fertility and productivity.

THEORY

Unit - I- Concepts of microbial inoculants

Biofertilizers - Definition - types, importance of biofertilizers in agriculture - *Rhizobium* - characters and classification - *Rhizobium* - legume symbiosis - nodule formation - Factors affecting nodulation and nitrogen fixation.

Unit-II- Nitrogen fixing biofertilizer

Characteristics and classification of *Azospirillum*, *Azotobacter*, *Gluconacetobacter*.- Actinorhizal plants (*Frankia*) and Algal biofertilizers - Blue green algae - Azolla.

Unit -III- Phosphate solubilizing/mobilizing biofertilizer

Problems of phosphorus uptake - fixation of phosphorus - microbial transformation of phosphorus- Phosphate solubilizing microorganisms, K, Zn and silicate solubilizing microorganisms - factors affecting phosphate solubilization- AM fungi - characteristics and types of mycorrhizae - Plant Growth Promoting Rhizobacteria (PGPR) - *Pseudomonas*.

Unit -IV- Formulations of biofertilizer

Different formulations of biofertilizers – Types and characters - carrier – beads – pellets and liquid formulation – preservatives and additives-shelf life of different formulations-quality control of different formulations - BIS.

Unit-V- Production technology

Mass Production technology of bacterial biofertilizers, Azolla , Algal biofertilizers and AM fungi – problem and constrains in production- method of application – Marketing and monitoring field performance-Economics of microbial inoculants. **Current stream of thoughts in microbial inoculant production.**

PRACTICAL

Isolation, screening for efficiency and strain improvement of different types of inoculants-*Rhizobium*, *Azospirillum*, *Azotobacter*, *Gluconacetobacter*, BGA and Phosphobacteria,. Mass multiplication techniques of *Rhizobium*, *Azotobacter*, *Gluconacetobacter*, *Azospirillum*, BGA and Phosphobacteria- AM fungi – Spore count and infection percentage- Fermentor-fermentation requirements-Types of carriers-preparation of carrier based inoculants-shelf life- methods of applications- Quality control of inoculants.

THEORY LECTURE SCHEDULE

1. Microbial inoculants in Agriculture.
2. Biofertilizers-definition-Development of the concept-
3. Contribution and importance of microorganisms to soil fertility.
4. Different groups of biofertilizers-bacterial,
5. Different groups of algal
6. Different groups of fungal biofertilizers etc.
7. Nitrogen fixing microorganisms-Phosphate solubilising microorganisms etc.
8. Symbiotic nitrogen fixing bacteria-*Rhizobium* classification-Cross inoculation groups- characteristics.
9. Infection-root nodule formation-leghaemoglobin-nitrogen fixation.
10. Assay of nitrogen fixation-Nitrogen assimilation.
11. Transfer of fixed nitrogen in symbiotic systems.
12. Associative symbiosis-*Azospirillum*-species distribution-Characterization.
13. Importance of *Glucoacetobacter* and its distribution.
14. Non-symbiotic nitrogen fixation-*Azotobacter*- Characterization.
15. Actinorhizal association-*Frankia*-Importance-location, biochemistry and physiology of actinorhizal nodules.
16. Phosphate solubilization by microorganisms-bacteria and fungi involved general characters and importance.
17. Algal biofertilizers - Blue green algae-distribution-occurrence.
18. Morphological variation-Characteristics.
19. Azolla-*Anabaena* symbiosis-Importance- Azolla growth behavior- multiplication-sporulation etc.
20. **Mid Semester Examination**
21. Mycorrhiza- types -Ectomycorrhiza –
22. Mycorrhiza- types -Endomycorrhiza.
23. Role of mycorrhiza in crop production.
24. Microbial inoculants for solubilization of potassium sulphur and trace elements.
25. Carrier materials-Types and quality characteristics of an ideal carrier, preparation of inoculant packets.
26. Different formulations of inoculants- carrier, gel, liquid formulations etc.
27. Principles of mass production-Large scale production of bacterial biofertilizers-growth characteristics.
28. Fermentation-Principles and techniques-inoculum preparation.

29. Shelf life-quality control of biofertilizers-BIS specifications.
30. Field performance of biofertilizers.
31. Method of application -Economics.
32. Algal multiplication-large scale production-application methods
33. Azolla-Mass multiplication and method of application etc.
34. Mycorrhizae-VAM-Mass scale production-field performance-problems and prospects of biofertilizers.

PRACTICAL SCHEDULE

1. Isolation of *Rhizobium* from legume root nodules; purification and characterization of *Rhizobium*
2. Testing the efficiency-Leonard jar technique and plant infection test.
3. *Rhizobium* strain identification by immunological methods.
4. Isolation of *Azospirillum* from roots Rhizosphere.
5. Identification and characterization of *Azospirillum*.
6. Isolation and identification of *Azotobacter* and *Gluconacetobacter*.
7. Isolation of phosphobacteria from soil.
8. Quantitative determination of P-solubilization by phosphobacteria.
9. Mass multiplication of bacterial biofertilizers-Fermentor
10. Carrier material-preparation of inoculant packets
11. Quality control-assessment of shelf life and storage methods
12. Methods of application of bacterial biofertilizers- seed, soil
13. Isolation, enumeration and identification of Blue green algae
14. Blue green algae-large scale production and method of application
15. Azolla-large scale production and inoculation methods.
16. Liquid and gel formulations biofertilizers.
17. Different genera of VA mycorrhizae and Mass multiplication of AM fungal-application methods.

Course outcomes:

CO 1 - To make the students to understand the concepts of microbial inoculants and their role on soil fertility and plant growth.

CO 2 - To learn about the isolation and characterization of efficient bioinoculant strains.

CO 3 - To educate about the various formulations of microbial inoculants with improved shelf life and their quality standards.

CO 4 - To know the techniques of mass multiplication, storage and methods of application of bioinoculants.

CO 5 - To make students to analyse the performance of microbial inoculants in field level, their constraints in production technology, marketing and economics.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference Books

1. S. Gianinazzi, Hannes Schüepp, J.M. Barea, K. Haselwandter.2012. Mycorrhizal Technology in Agriculture: From Genes to Bioproducts. Birkhäuser publisher
2. Umesh Chandra Mishra 2015. Facts for Liquid Biofertiliser. Partridge Publishing, Singapore. S.G. Borkar. 2015. Microbes as Bio- fertilizers and their Production Technology. Wood head publisher. New Delhi.

3. P.Hyma. 2017. Biofertilizers: Commercial production Technology and quality control. Random publishers. New Delhi.
4. Bhattacharyya.,P and Tandon HLS.2002.Dictionary of Biofertilizers and Organic Fertilizers. Fertilizer Development and Consultation Organization, New Delhi. 1 - 165.
5. Motsore, M.R., P.Bhattacharayya and Beena Srivastava, 2001. Biofertilizer Technology,Marketing and usage - A source Book - cum - glossary - FDCO, New Delhi, P. 584.

E reference

1. <https://www.ncbi.nlm.nih.gov/pmc>
2. <https://www.researchgate.net>
3. <https://www.sciencedirect.com/science/>

OPCAGM 712- INDUSTRIAL MICROBIOLOGY (2+1)

Learning objectives

To teach the students about different fermentations, industrial important microorganisms and the mass production techniques .

THEORY

Unit- I- Introduction of fermentation

History of industrial microbiology - Isolation and screening methods - strain development strategies - fermentation media - raw materials used in media production and antifoam agents - fermentation process- dual and multiple fermentation process - batch and continuous fermentation, soild state and submerged fermentation.

Unit-II- Bioreactors and its types

Bioreactors - basic functions - types, designs and functional characteristics- upstream and downstream processing - automation of bioreactors.

Unit -III- Production of organic solvents organic acids , amino acids and Beverages

Production of organic solvents such as ethyl alcohol and glycerol. organic acids production - butyric acid, citric acid and lactic acid . Amino acid production - lysine and glutamic acid. Beverages production - beer and wine. - Alcohol production

Unit- IV- Production of Antibiotic Vitamin and Enzymes

Industrial production of antibiotics - penicillin , streptomycin and tetracycline production of vitamin B2 (Riboflavin), vitamin B12 and vitamin C. production of enzymes - amylase, protease, cellulase, pectinase and lipase immobilization and its type.

Unit- V- Fermented food products, biofertilizers and biopesticides production techniques

Milk and dairy product production - yoghurt, buttermilk, cultured milk and cheese - mass production of bacterial biofertilizers - *Azospirillum*, *Rhizobium* and phosphobacteria. mass production of Bio insecticides - *Bacillus thurigiensis*, *Beauveria bassiana* and *Metarhizum anisopilae*. Mass production of *Pseudomonas fluroscens* and *Trichoderma viridae*. **Current stream of thoughts in industrial microbiology.**

PRACTICAL

Isolation and screening of industrial important microorganisms- preparation of inoculums - bioreactors - fermentation of alcohol , wine making - production of penicillin - antibiotics sensitivity test of penicillin , streptomycin and tetracycline organic acids , enzymes, production of curd , mass production of bacterial biofertilizers and bio control agents.

THEORY LECTURE SCHEDULE

1. History of industrial microbiology
2. Screening methods
3. Strain improvement of microorganisms

4. Methods of strain improvement
5. Fermentation media and their raw materials
6. Fermentation process of its Types
7. Bioreactors , design and functional characteristics
8. Types of bioreactors
9. Upstream processing
10. Downstream processing- introduction
11. Details of down steam processing
12. Production of organic solvents –ethyl alcohol and glycerol
13. Production of organic acid – Butyric, citric and Latic acid
14. Production of Amino acid - Lysine and glutamic acid
15. Production of Beverages - Beer and wine alcohol production
16. Production of pencillin , streptomycine and tetracycline
17. **Mid semester Examination**
18. Production of amylase and protease
19. Production of pectinase , cellulose
20. Production of Lipase
21. Immobilization and its types
22. Milk product – Butter milk and culture milk
23. Yoghurt production
24. Cheese production
25. Bacterial bio fertilizer production – *Azospirillum*
26. *Rhizobium* mass production
27. Phosphobacteria mass production
28. Quality control and method of application
29. Production of bioinsecticides – *Bacillus thuringiensis*
30. Mass production of *Beavria bassiana*
31. Mass production of *Metarhizum anisopliae*
32. Mass production of *Pseudomonas fluosceus*
33. Mass production of *Trichoderma Viridae*
34. Review of Lectures

PRACTICAL SCHEDULE

1. Isolation of industrial important microorganisms from soil and buttermilk/ curd.
2. Strain improvement – Induced mutation of bacteria.
3. Preparation of Inoculum
4. Bioreactors and its functional characteristics
5. Alcohol production from Jaggery
6. Wine making
7. Amylase production
8. Citric acid production by solid waste fermentation
9. Antibiotic sensitivity test – penicillin streptomycin and tetracycline
10. Extra – cellular amylase production
11. Production of penicillin
12. Production of enzymes using immobilization techniques
13. Mass production of *Rhizobium* biofertilizer
14. Mass production of phosphobacteria
15. Mass production of Bioinsecticide *Bacillus thuringiensis* (or) *Beauveria bassiana* (or) *Metarhium anisopilae*
16. Mass production of *Pseudomonas fluorescens* and *Trichoderma viride*
17. **Practical Examination**

Course outcome:

CO 1 - To learn about the important industrial microbes and their products.

CO 2 - To learn about the strategies to improve the strain efficiency and preservation techniques for future purposes.

CO 3 - To make the students to understand the concepts and types of fermentation process, types of fermentor, their design and purposes.

CO 4 - To gain knowledge on the techniques of industrial production of organic acids, antibiotics, enzymes and fermented foods.

CO 5 - To train the students to develop skills on the techniques of mass production of biofertilizers and bio pesticides.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference Books

1. Byong H. Lee. 2014. Fundamentals of food Biotechnology, 2nd Ed. Springer.
2. Casida LE. 1999. Industrial Microbiology. New age International Publishers.
3. Crueger W and Crueger A. 2000. Biotechnology: A text Book of Industrial Microbiology, 2nd edition. Panima Publishing Corporation.
4. Cruger W and Crueger A. 2017. Biotechnology- A text book of Industrial microbiology (Third edition) Sinaue Associates International USA.
5. Hongzhang chen 2013. Modern Solid State Fermentation Theory and Practice. Springer.
6. Karthikeyan, B. and R.Elango 2010. Fermentation Technology, Srivelan Pathipagam Chidambaram.
7. Casida LE. 2016. (Revised) Industrial Microbiology , New age international publisher New Delhi
8. Prescott and Dunn 2000. Industrial Microbiology AVI publishing co; West port Connecticut, USA.
9. Reed G. 2004. Industrial Microbiology by CBS Publishers (AVI Publishers Co.)
10. Saravana muthu R. 2010. Industrial Exploitation of Microorganisms. IK international Pvt. Ltd.
11. Sivakumar,P.K, M.M.Joe and sukesh, 2013. An Introduction to industrial Microbiology, S.Chand Pvt. Ltd, Newdelhi
12. Stanbury and Whitaker, Principles of fermentation Technology.
13. Waites MJ et al., 2001. Industrial Microbiology by Blackwell Science.

E- references

1. <https://www.sciencedirect.com/...and.../industrial-microbiolog>
2. <https://books.google.co>
3. <https://fordham.libguides.com>

OPCSAC 711 SOIL, WATER AND AIR POLLUTION (2+1)

Learning Objectives

To make the students aware of soil, water and air pollution and their remediation for the use of agriculture, environment and human health.

THEORY

Unit I - Types of pollution

Pollution- pollutants – introduction, definition- types of pollution -classification of pollution based on the environment - soil, water and air pollution - classification of pollution based on the sources of pollutants – agricultural pollution, automobile pollution and industrial pollution - classification of pollution based on the nature of pollutants – pollution due to fertilizer, pesticides, herbicides, fungicides, weedicides and other agro – chemicals, Plastic pollution, heavy metal pollution, radiation pollution, oil pollution, sewage pollution and etc.,

Unit II - Soil pollution

Soil pollution – definition- sources – extent – solid waste as pollutants cause soil pollution in agriculture and environment. Land application of waste and mechanism of interaction of waste with soil. Soil contamination – introduction - definition- causes – its effect on soil microorganisms. CPC standards in soil and its effect on plant.

Soil as sink for waste disposal - Industrial effluents – distillery, papermill, tannery, textiles and metal finishing effluents – their composition. Its effect on soil properties, plant growth and human health. Toxic elements or heavy metals – sources, behaviors in soil, its effect on soil nutrient availability, plant growth and human health.

Unit III - Water pollution

Pure water, contaminated water, polluted water- definitions, quality parameters used to monitor water pollution. Pollution of water resources due to leaching of nutrients and its impact on aquatic eco - system, water pollution due to use of pesticides in agriculture and its impact on aquatic eco-system. Sewage – sludge- sewerage – definition –sewage treatment- eutrophication – important water borne diseases for crops and human beings.

Unit IV - Air pollution

Air pollution – introduction – airborne microbes- classification of air pollutants - global warming, ozone layer depletion and acid rain – emission of green house gaseous- sources - carbon-dioxide , carbon monoxide, methane, CFC, HFC, carbon tetra chloride, nitrous oxide and etc.,

Unit V - Management of pollutions and preventive measures

Reclamation - soil, water and air pollution, biological transformation of heavy metals, bio-mining of metals- solid waste management -bio-remediation. Application of remote sensing in monitoring and management of soil, water and air pollution for the benefit of agriculture, environment and human health. **Current stream of thoughts in water and soil pollution.**

PRACTICALS

Sampling of sewage water, sewage sludge, sampling of solid and liquid industrial wastes, sampling of polluted soil and polluted plant. Estimation of ammoniacal nitrogen, nitrate nitrogen and phosphorus in polluted soil and plant. Estimation of heavy metals content in polluted soil, plant, water and effluent. Estimation of chemical oxygen demand (COD) and biological oxygen demand (BOD) in polluted water and effluent. Management of contaminants in soil and plants for safeguard of food safety. Air sampling. Determination of particulate matter and oxides of sulphur. Visit to various industrial sites to study the impact of pollutants on soil, water, plant and environment.

THEORY LECTURE SCHEDULE

1. Pollution- pollutants – Introduction, definition- different types of pollution
2. Classification of pollution based on the environment- soil, water and air pollutions
3. Classification of pollution based on sources – agricultural, automobile pollution and industrial pollutions
4. Classification of pollution based on the nature of pollutants – pollution due to fertiliser, pesticides, herbicides, fungicides, weedicides and other agro – chemicals
5. Classification of pollution based on the nature of pollutants – Plastic, heavy metal, radiation, oil pollution, sewage pollution and etc.,

6. Sources and extent of pollution, problems in agriculture, environment and human health due to type pollutions
7. Solid wastes – definition, land application of wastes
8. Mechanism of interaction of waste with soil
9. Agricultural, industrial and urban wastes
10. Soil contamination – introduction - definition- in relation with soil microorganisms
11. Soil contamination due to fertilizers, pesticides, fungicides, weedicides, acid rain, oil spills, plastics and etc.,
12. Industrial effluents – distillery, papermill, tannery effluents – their composition
13. Industrial effluents – textiles and metal finishing industrial effluents – their composition
14. Effects of industrial effluents on soil properties, plant growth and human health
15. Soil as sink for waste disposal
16. Toxic elements – sources, behaviors, nutrient availability, plant growth and human health
17. **Mid – semester examination**
18. Pure water , contaminated water, polluted water- introduction, definitions
19. Quality parameters used to monitor water pollution
20. Pollution of water resources due to leaching of nutrients and its impact on aquatic eco system
21. Water pollution due to use of pesticides in agriculture and its impact on aquatic eco-system
22. Sewage – sludge- sewerage – definitions –sewage treatment- eutrophication – important water borne diseases
23. Air pollution – introduction – airborne microbes- classification of air pollutants
24. Global warming , ozone layer depletion and acid rain –
25. Emission of green house gaseous- sources - carbon-dioxide , carbon monoxide, methane, CFC, HFC, carbon tetra chloride and nitrous oxide
26. Reclamation of soil contamination for the use of agriculture and
27. Remediation of water pollution
28. Amelioration of air pollution
29. Heavy metal pollution, its effect on human health , biological transformation of heavy metals
30. Bio - mining of metals, bio-remediation of heavy metals
31. solid waste – definition- objectives - classification
32. Solid waste treatment, solid waste management
33. Application of remote sensing in monitoring and management of soil for the benefit of agriculture, environment and human health
34. Application of remote sensing in monitoring and management of water and air pollution for the benefit of agriculture, environment and human health

PRACTICAL SCHEDULE

1. Sampling of polluted soil /plant/water/effluent/ sewage for analysis
2. Estimation of ammoniacal nitrogen in polluted soil or plant
3. Estimation of nitrate nitrogen in polluted soil or plant
4. Estimation of phosphorus in polluted soil or plant
5. Estimation of ammoniacal nitrogen in polluted water of effluent
6. Estimation of nitrate nitrogen in polluted water or effluent
7. Estimation of phosphorus in polluted water or effluent
8. Visit to various industrial sites to study the impact of pollutants on soil, water, plant and environment.
9. Estimation of heavy metals in polluted soil or plant

10. Estimation of heavy metals in polluted water or effluent
11. Estimation of chemical oxygen demand (COD) in polluted water or effluent
12. Estimation of biological oxygen demand (BOD) in polluted water or effluent.
13. Assessment of microorganisms in air
14. Management of contaminants in soil and plants for safeguard of food safety
15. Practical examination

Course Outcomes

Co 1. Scholars gain knowledge on environmental pollution and conservation.

Co 2. Students understand the methods of abatement of various types of pollution towards a safe environment.

Co 3. Scholars will be able to communicate the ill- effects of environmental pollution to farmers.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference Books

1. Andrew Skidmore. 2003. Environmental Modeling with GIS and Remote Sensing. CRC Press .
2. Armando C. Duarte, Anabela Cachada, Teresa A.P. Rocha - Santos. 2017.
3. Soil Pollution-From Monitoring to Remediation. Elsevier Science. Das, B.C. 2017. Environmental studies. Kalyani publishers. New delhi
4. Frank Den Hond, Peter Groenewegen, Nico van Straalen. 2008. Pesticides Problems, Improvements, Alternatives. Wiley.
5. Misra,S.G. and Dinesh mani. Soil pollution.2009. APH Publishing Corporation. New Delhi.
6. Mishra,P.C. Soil pollution and soil organisms.2008. APH Publishing Corporation. New Delhi.
7. Moliwal,G.L. and Patel K.P., .Heavy metals in soils and plants.2011.Agrotech publishing Academy, Udaipur.Methods in environmental analysis water, soil and air.2nd edition. 2007. Agrobios. Jodhpur.
8. Peter A. Victor. 2017. Pollution. Economy and Environment. Taylor and Francis.
9. Ramanathan,N. and Muthukkaruppan, S.M.. 2012. A text book of environmental microbiology. Om shakthi pathippagam. Annamalainagar.
10. Singh,K.K,Juwarkar Asha, Singh,A.K. Tomer Alka. 2016. Air, Water and Soil pollution. Kalyani publishers.New delhi.
11. Suresh T.Nesaratnam.2014. Water Pollution Control.Tushar Kanti Sen.2017. Air, Gas, and Water Pollution Control Using Industrial and Agricultural Solid Wastes Adsorbents. CRC Press.

E- Books

1. <https://www.ebooks.com/95527356/phytoremediation/ansari-abid-a-gill-sarvajeet-singh-gill-ritu-lanza/>.
2. <https://www.ebooks.com/180494/environmental-modelling-with-gis-and-remote-sensing/skidmore-andrew/>.
3. <https://www.ebooks.com/95881311/soil-pollution/duarte-armando-c-cachada-anabela-rocha-santos-tere/>.
4. <https://www.ebooks.com/214163/pesticides/den-hond-frank-groenewegen-peter-van-straaalen-nico/>.

5. <https://www.ebooks.com/95889867/pollution/victor-peter-a/>.
6. <https://www.ebooks.com/2642553/air-pollution/scorer-r-s-scorer-r-s/>.

OPCSAC 712 SOIL HEALTH MANAGEMENT (2+1)

Objectives

The main objectives of this course is to impart practical knowledge on soil related constraints, irrigation water quality appraisal guidelines and their efficient management, soil quality and soil quality test kits-soil health card

THEORY

Unit I - Soil related constraints and their management

Soil resources of India; distribution of wasteland and problematic soils with special reference to Tamil Nadu ; soil tilth management; soil crusting and its management; management of soil moisture under different climates. Reclamation and management of acidic, saline and sodic soils, constraints and management of highly and slowly permeable soils; soil erosion, extent, type and effects.

Unit II - Irrigation water quality appraisal and its management

Effect of water quality on soils and plants; soil aeration problems and management; soil thermal regimes in relation to crops and their optimization. Recycling of agricultural and industrial wastes, waste land and their management.

Unit III - Soil organicmatter

Management practices-Sustainability and soil health management-history and importance of organic matter management- Soil organic carbon conservation and sequestration-Characterisation of soil carbon pools under different land use management systems-Soil quality and resilience in relation to SOC pools

Unit IV - Soil nutrient management

Tools and techniques to build soil health- Biological methods of improving nutrient use efficiency-Biological nitrogen fixation- Biological phosphorus. Mobilization/immobilisation-microbial inoculants for plant growth promotion- Biofertilizer technology-green manures, green leaf manures- Composting vermicomposting- nutrient enriched manures- quality standards for organic manures large scale compost production-Scope of land use management on carbon trading- Soil bioremediation- Nutrient management - Organic farming and soil health.

Unit V - Soilquality management

Soil quality characters-Indicators of soil quality-Non Quantitative- quantitative-Chemical -Physical Biological -Assessment of soil health- Assessment as a monitoring tool-Lab based assessments -Concept of minimum data set -indicator selection interpreting indicators-multifactor sustainability-sustainability index-Indexing soil quality-Soil quality test kits-Soil health card. **Current stream of thoughts in soil health.**

PRACTICAL

Determination of saturated hydraulic conductivity, bulk density measurement of soil measurement of water holding and field capacities of soil, measurement of infiltration rate and moisture retention characteristics curve in normal, problematic and reclaimed soils. Preparation of saturation paste and saturation extracts of salt affected soils. Determination of pH, EC, cations and anions in saturation extract. Determination of CaCO₃ equivalent of liming material. Estimation of lime requirement of acid soils and gypsum requirement of sodic soils. Measurement of ODR of soil. Estimation of water stable aggregate in soil and field trip to study the areas of problematic soils.

THEORY LECTURE SCHEDULE

1. Soil resources of India; distribution of wasteland and problem soils
2. Soil tilth management, soil crusting and their management

3. Soil water: classification, and its measurement, forces of soil water retention, moisture retention curve
4. Management of soil moisture under different climates
5. Quality of irrigation water: Criteria and classification of poor quality water,
6. Effect of poor quality of water on soil and crop growth, management of poor quality water.
7. Soil air: Composition of soil air, gaseous exchange in soil.
8. Management of soil aeration in relation to plant growth.
9. Soil temperature and thermal regimes in relation to crop growth.
10. Factors affecting soil temperature and optimization of soil thermal regimes.
11. Recycling of Agricultural and industrial organic waste.
12. Acid soils: Extent, reclamation and management in India and Tamilnadu.
13. Nomenclature, classification and formation of salt affected soils in India and Tamilnadu,
14. Visual and chemical methods of diagnosing salt affected soils.
15. Reclamation and management of salt affected soils
16. Highly and low permeable soils: constraints and their management
17. **Mid Semester Examination**
18. Management practices-sustainability and soil health management.
19. History and importance of organic matter management.
20. Soil organic carbon conservation and sequestration.
21. Characterisation of soil carbon pools under different land use management systems-Soil quality and resilience in relation to SOC pools
22. Tools and techniques to build soil health
23. Biological methods of improving nutrient use efficiency
24. Biological nitrogen fixation-Biological phosphorus mobilization/ immobilisation
25. Microbial inoculants for plant growth promotion
26. Biofertilizer technology; green manures, green leaf manures
27. Composting vermicomposting; nutrient enriched manures
28. Quality standards for organic manures large scale compost production
29. Scope of land use management on carbon trading
30. Soil quality characters-Indicators of soil quality-Non Quantitative-quantitative
31. Chemical –Physical Biological –Assessment of soil health
32. Assessment as a monitoring tool-Lab based assessments
33. Concept of minimum data set –indicator selection interpreting indicators-multifactor sustainability-sustainability index.
34. Indexing soil quality and soil quality test kits-Soil health card

PRACTICAL SCHEDULE

1. Techniques of reclamation / management of problematic soils
2. Determination of saturated hydraulic conductivity of normal, problematic and reclaimed soil.
3. Determination of bulk density of soil by core sampler method in normal, problematic and reclaimed soil.
4. Determination of soil moisture at 1/3 and 15 bar by pressure plate method in normal, problematic and reclaimed soil.
5. Measurement of water holding capacity and field capacity of soil
6. Measurement of infiltration rate of soil by double ring infiltrometer in normal, problematic and reclaimed soil.
7. Preparation and analysis of saturation extract and determination of EC, pH
8. Determination of Ca + Mg and Na in saturation extract and computation of SAR
9. Determination of CO₃, HCO₃ and Cl in saturated extract.

10. Determination of CaCO₃ equivalent of liming material
11. Estimation of lime requirement of acid soils
12. Estimation of gypsum requirement of sodic soils
13. Measurement of ODR of soil in normal, problematic and reclaimed soil
14. Estimation of water stable soil aggregates in normal, problematic and reclaimed soil
15. Soil Health assessment- Determination of Soil Quality indices
16. Preparation of Soil Health card
17. **Practical Examination**

Course Outcomes

Co1. Scholars achieve practical knowledge on soil related constraints and management.

Co2. Scholars gain knowledge on irrigation water quality and their management

Co3. Scholars become professionals in handling tools on soil health maintenance.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference books

1. Basak Ranjan Kmar, 2017. Soil Testing and Recommendation. Kalyani Publishers, New Delhi.
2. Biswas, T.D. and Mukherjee, S.K. 2006. Text book of soil science. Tata McGraw Hill publishing Co. Ltd, New Delhi.
3. Brady, N.C. and Weil, R.R. 2002. The nature and properties of soils, prentice hall of India Pvt. Ltd, M-97, Connaught Circus, New Delhi.
4. Das D.K., 2017. Introductory Soil Science. Kalyani Publishers, New Delhi.
5. Das, D.K. 2002. Introductory Soil Science, Kalyani publisher, New Delhi.
6. ISSS 2002. Fundamentals of Soil Science, Div. of Soil Science, IARI, New Delhi.
7. Jaiswal P.C., 2013. Soil, Plant and Water Analysis. Kalyani Publishers, New Delhi.
8. Mehra R.K. 2004. Text book of Soil Science, ICAR, New Delhi.
9. Rai, M.M. 2002. Principal of Soil Science Mac Millan India Ltd, New Delhi.
10. Ranjan kumar Bansal, 2000. Soil Testing and Recommendation. Kalyani Publishers, New Delhi.
11. Sahai V.N., 2017. Fundamentals of Soil. Kalyani Publishers, New Delhi.

Reference-E -books

1. <https://www.conserve-energy-future.com/organic-farming-benefits>
2. https://en.wikipedia.org/wiki/Soil_Health_Card
3. www.soilhealth.com/soil-health/management
4. <https://casfs.ucsc.edu/about/publications/Teaching-Organic>
5. <https://link.springer.com>
6. <https://www.noble.org/news/publications/ag.../management-of-salt-affected-soils>

OPCGPB 621 CONCEPTS OF CROP PHYSIOLOGY (2+1)

Objectives

- To impart knowledge in understanding the physiological processes taking place during growth and development of plants.
- To understand source sink relationship in different groups of plants and also hormonal, environmental and stress physiology in crop plants.

Theory

Unit I - Photo physiology

Role of physiology in different branches of agriculture. Physiological processes on productivity - Photosynthesis - Mechanism of light interaction. Physiological processes influenced by radiation. Light and phytochrome mediated processes. - CO₂ reduction - utilization of assimilatory power and carbohydrate synthesis - C₃, C₄ and CAM mechanisms - Major differences.

Unit II - Growth and Development

Growth Vs Development.. Dry Matter Accumulation and Harvest Index - components of Dry Matter Accumulation and Harvest Index and their role in productivity. Growth analysis. Photorespiration and dark respiration.

Unit III - Source sink relationship

LAI and its components -interception of solar energy. Photosynthates partitioning - source - sink relationship - mode of partitioning at different stages in different species. Role of growth regulators in monitoring source and sink.

Unit IV - Environmental physiology

Green house effect and Global warming. Ozone layer depletion - Causes, effects. CO₂ enrichment and plant productivity. Physiology of crops under high altitude and flooding - air pollution and plant growth - effect of effluent on plant growth.

Unit V - Stress physiology

Mechanisms of drought, salt, cold, heat and UV radiation stress tolerance - adaptation of crop plants - crop management practices under unfavourable situations - Importance of selection indices for crop productivity - recent advances in physiological research.

Practical

Leaf Area measurement - measurement of leaf angle and interception of solar radiation - light transmission ratio - measurement of photosynthesis - difference in the photosynthetic rate between the leaves at different position - photosynthetic efficiency of C₃ and C₄ plants - estimation of chlorophyll - RuBP case and PEP case - Measurement of respiration - Growth regulation - response to source and sink relationship - Measurement of water potential and its component. Measurement of leaf temperature, diffusive resistance and transpiration rate - use of antitranspirants - yield component analysis - study of selection indices.

Lecture Schedule

Theory

1. Role of physiology in different branches of agriculture
2. Physiological processes on productivity
3. Photosynthesis - Mechanism of light interaction
4. Photo Physiology
5. Physiological processes influenced by radiation
6. Light and phytochrome mediated processes
7. Utilization of assimilatory power and CH₂O synthesis
8. C₃-C₄ and CAM mechanisms and major differences
9. Photosynthetic measurements
10. Germination, growth and development
11. DMA and HI. Components of DMA and HI.
12. Role of DMA, LAI and HI in crop productivity
13. Growth analysis
14. Photorespiration and dark respiration
15. Oxidative phosphorylation.
16. Release and utilization of energy for various metabolisms.
17. **Mid-Semester Examination**

18. Interception of solar energy
19. Source-sink relationship
20. Photosynthate partitioning
21. Mode of partitioning at different stages and different species
22. Role of growth regulators in monitoring source-sink relationship
23. Growth regulators – auxins, gibberellins and cytokinins, biosynthesis, functions and agricultural role.
24. Abscisic acid and ethylene. Biosynthesis, functions and agricultural role.
25. Growth retardants. Role in agricultural and horticultural crops
26. Green house effect and plant productivity.
27. CO₂ enrichment and plant productivity.
28. Physiology of crops under high altitude flooding, air and water pollution
29. Water stress, effect of water stress on various physiological processes
30. Mechanisms of adaptation to stress condition.
31. Salt stress, classifications and its effects on physiological processes of plant
32. Temperature stress – cold tolerance – adaptation
33. Heat stress – Heat shock proteins – heat tolerance – adaptation.
34. Recent advances in physiological research

Practical Schedule

1. Leaf area index measurement. Measurement of leaf angle and interception of solar radiation
2. Measurement of photosynthesis
3. Determination of Photosynthetic efficiency of various crop plants
4. Estimation of soluble protein content
5. Estimation of chlorophyll contents
6. Estimation of water potential
7. Determination of chlorophyll stability index
8. Estimation of relative water content
9. Estimation of leaf proline content
10. Measurement of leaf temperature, diffusive resistance and transpiration
11. Growth analysis of field crops
12. Determination of nitrate reductase activity
13. Determination of IAA oxidase activity
14. Estimation of total phenolics
15. Estimation of peroxidase activity
16. Estimation of catalase activity
17. **Final Practical Examination**

Course outcomes

1. Will be able to identify the crop mineral nutrient deficiencies and their symptoms
2. In addition, hands on exposure to preparation of solutions, analysis of pigment composition, estimation of growth analytical parameters,
3. Will be able to diagnose and correct nutrient deficiencies,
4. Will be competent in enzyme assays and application of plant growth regulators.

CO-PO Mapping with POs of Agricultural Entomology

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

References

1. Devlin, B. 1983. Plant Physiology. Narosa Publishing House, New Delhi.
2. Franklin P. Gardner, R. Brent Pearce and Roger L. Mitchell, 1988. Physiology of crop plants. Scientific Publishers, Jodhpur.
3. Gupta, U.S. 1988. Progress in Crop Physiology. Oxford IBH Publishing Co. Pvt., Ltd., New Delhi.
4. Kumar, A. and S.S. Purohit. 1996. Plant Physiology. Agro Botanical Publishers, Bikaner.
5. Lincoln Taiz, Eduardo Zeiger. 2002. Plant Physiology 2nd Edition. Replica press Pvt. Ltd., Delhi.
6. Noggle, G.R. and G.J. Fritz. 1986. Introductory Plant Physiology. Prentice Hall of India Ltd., New Delhi.
7. Panday, S.N. and B.K.Sinha. 1972. Plant Physiology. Vikas Publishing House Pvt. Ltd., New Delhi.
8. Price, C.A. 1974. Molecular approaches to plant physiology. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
9. Purohit, S.S. 2005, Plant Physiology. Student Edition Agrobios, Jodhpur.
10. Purohit, S.S., Q.J. Shammi, and A.K. Agrawal, 2005. A Text book of Environmental sciences, Student Edition, Agrobios, Jodhpur.
11. Salisbury, F.B. and C.M.Ross. 2004. Plant Physiology. Thomson and Wadsworth publications, Belmont, California.

OPCABT 711 BIO-INSTRUMENTATION (2+1)

Objective

- To provide hands on training on basic molecular biology techniques
- To provide the knowledge of various technology in field of molecular biology

Unit I - Spectroscopy & Microscopy

Spectroscopy-Principle, instrumentation and applications of UV - visible spectrophotometry and spectrofluorimetry-luminometry-Atomic spectroscopy- Microscopy-SEM and TEM.

Unit II - Centrifugation

Basic principles of sedimentation-Clinical Bench Centrifuges-High Speed Refrigerated Centrifuges-Continuous flow Centrifuges-Ultracentrifuges-Analytical ultracentrifuge - instrumentation and applications-Preparative ultracentrifuge

Unit III - Chromatography

Principle of chromatography-Types- Column Chromatography-Paper Chromatography-Thin Layer Chromatography-Gas Chromatography-High Performance Liquid Chromatography-Affinity Chromatography-Ion-Exchange Chromatography

Unit IV - PCR and Electrohoresis

PCR-principles. RT-PCR. Real time PCR-DNA/RNA-Agarose gel electrophoresis-Principles-Protein electrophoresis-principles-SDS and Native PAGE, 2D-gel electrophoresis.

Unit V - Blotting techniques

Blotting techniques-Southern-Northern-Western. DNA sequencing techniques, Dot blot analysis-ELISA- Immunoelectrophoresis, RIA, immunoblotting

Practical

Centrifugation techniques - Chromatography - Electron microscopy -Electrophoresis of DNA and proteins-PCR-blotting techniques-DNA sequencing techniques.

Lecture schedule

Theory

1. Good lab practices
2. Preparation of buffers and reagents,

3. Principle of centrifugation
4. Analytical and preparative centrifugation
5. Principle involved in Chromatography
6. UV and Nano drop spectrophotometer
7. Ion exchange spectroscopy
8. Atomic absorption spectroscopy
9. Electron microscopy
10. TEM and SEM.
11. Agarose gel electrophoresis
12. Electrophoresis of proteins-principles
13. Native and SDS PAGE
14. Gradient gel
15. Isoelectric focusing
16. 2-D PAGE.
17. **Mid- semester examination**
18. Detection, estimation of proteins
19. Recovery of proteins in gels,
20. Autoradiography
21. PCR- principle and applications
22. Mid semester examination
23. Modified PCR techniques
24. Reverse transcriptase PCR
25. Real time PCR
26. DNA Sequencing
27. Chemical method
28. Enzymatic method
29. Blotting techniques: Southern
30. Northern blotting techniques
31. Western blotting techniques.
32. Immunoelectrophoresis
33. RIA
34. Dot blots technique and immunoblotting.

Practical schedule

1. Preparation of stock solutions and reagents.
2. Extraction of plant genomic DNA by Dellaporta method.
3. Extraction of plant genomic DNA by CTAB method.
4. Centrifugation technique
5. Chromatography technique
6. UV- spectrophotometer
7. Restriction digestion of DNA.
8. Southern transfer, labelling of DNA, Southern hybridization.
9. Northern and western blotting procedure
10. Autoradiography.
11. Amplification of DNA with thermocycler with random primers.
12. Analysis of PCR products through agarose gel eletrophoresis and gel scanning.
13. Primer designing
14. DNA sequencing.
15. Genomic library construction
16. ELISA
17. **Final Practical Examination**

Outcomes

1. Ability to understand diagnosis and repair of related equipments
2. Understanding the problem and ability to identify the necessity of an equipment to a specific problem
3. Ability to take measurements involved in some agricultural equipments.

CO-PO Mapping with POs of Agricultural Entomology

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

Suggested Readings

1. Wilson and Walker. A biologist's guide to principles and techniques of practical biochemistry. 5th ed. Cambridge University Press 2000.
2. Boyer, R. Modern Experimental Biochemistry. 3rd ed. Addison Wesley Longman, 2000.
3. Upadhyay, Upadhyay and Nath. Biophysical Chemistry Principles and Techniques. Himalaya Publ. 1997.
4. Simpson CFA & Whittacker, M. Electrophoretic techniques.
5. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory, 2001.
6. Friefelder and Friefelder. Physical Biochemistry - Applications to Biochemistry and Molecular Biology. WH Freeman & Co. 1994.
7. Pavia et al. Introduction to Spectroscopy. 3rd ed. Brooks/Cole Pub Co., 2000.

OPC-ABT 712 PLANT TISSUE CULTURE (2+1)**Objective**

- To familiarize the students and provide hands on training on various techniques of plant tissue culture.
- The students will learn how the genes can be cut and pastes from one organism to another and what are its implications

Theory**Unit I - Basic principles**

History of plant cell and tissue culture; Culture media- sterile techniques - Media in plant tissue culture-Plant Growth Regulators-Components of a Plant Tissue Culture Medium-Explants-callus-totipotency-Basic concepts Plant tissue culture.

Unit II - Micropropagation method

Basic techniques in plant tissue culture-Techniques in Micropropagation- stages- Organogenesis-somatic embryogenesis-Virus free plants production

Unit III - In vitro culture techniques

Callus culture- Suspension culture- Single cell culture- Organ culture- Seed, embryo, endosperm, nucellus, shoot, root, leaf, anther and ovary. Protoplast culture-somatic hybridization-cybrids.

Unit IV - Haploids production

Embryo rescue techniques-artificial seeds-Haploid production & diploidization-Somaclonal variation- *In vitro* germplasm conservation- Application of plant cell culture in crop improvement.

Unit V - Genetic engineering

Plant transformation methods- *Agrobacterium*-Biolistic gun- Analysis of transgenic plants- Application of genetic engineering in crop improvement and crop productivity - resistance to disease - herbicides-quality characters.

Practical

PCR- Variation in PCR- RT - PCR - PCR - based analysis of transformants - Primer designing-Induction and analysis of crown gall tumour in intact plant - Isolation of Ti-Plasmid. Isolation of DNA and organelle DNA - *Agrobacterium* mediated transfer

Lecture Schedule

Theory

1. Laboratory organization-sterile techniques
2. Nutrition of plant cells-media composition.
3. History of plant cell and tissue culture
4. Culture media-Sterile techniques
5. Media in plant tissue culture
6. Plant Growth Regulators
7. Components of a Plant Tissue Culture Medium
8. Explants-callus-totipotency
9. Basic concepts Plant tissue culture.
10. Basic techniques in plant tissue culture
11. Micropropagation stages-Organogenesis-Somatic embryogenesis
12. Virus free plants production
13. Callus culture
14. Midterm examination
15. Suspension culture
16. Single cell culture.
17. **Mid-semester examination**
18. Organ culture
19. Seed, embryo, endosperm, nucellus
20. Shoot, root, leaf culture
21. Protoplast culture
22. Somatic hybridization-cybrids.
23. Embryo rescue techniques
24. Artificial seeds
25. Haploid production-diplodization
26. Somaclonal variation
27. *In vitro* germplasm conservation
28. Application of plant cell culture in crop improvement
29. Plant transformation methods
30. *Agrobacterium* mediated gene transfer
31. Biolistic gun
32. Genetic and molecular analyses of transgenics
33. Genetic engineering for resistance to insect pests
34. Genetic engineering for resistance to herbicides and quality characters.

Practical

1. Laboratory set-up.
2. Preparation of nutrient media; handling and sterilization of plant
3. Explant inoculation, subculturing and plant regeneration.
4. Anther and pollen culture.
5. Embryo rescue.
6. Suspension cultures and production of secondary metabolites.
7. Protoplast isolation, culture and fusion.
8. Preparation of microprojectiles, transformation using a particle gun, GUS staining.
9. Leaf disc transformation using *Agrobacterium*, establishment of transgenic plants, and
10. DNA extraction from transgenic plants, DNA estimation

11. Protein extraction
12. Agarose and PAGE electrophoresis
13. Southern blot analysis to prove T-DNA integration
14. PCR
15. RT-PCR to study transgene expression
16. Western blotting to study the accumulation of transgene-encoded protein.
17. **Final Practical Examination.**

Course Outcomes

1. Standardize protocols for the in vitro propagation from ex vitro explants
2. To optimize the culture conditions for rapid propagation and regeneration of agriculturally important plants.
3. Biochemical monitoring of explants proliferation and regeneration
4. Optimization of medium and culture conditions for the enhancement of active principle production
5. Biochemical characterization of regeneration and genetic transformation using Agrobacterium.

CO-PO Mapping with POs of Agricultural Entomology

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

Suggested Readings

1. Bhojwani SS. 1983. Plant Tissue Culture: Theory and Practice. Elsevier
2. Gamborg OL and Philips GC. 1995. Plant Cell, Tissue and organ culture. Fundamental Methods, Narosa Publishing House, New Delhi.
3. Potrykus F and Spangenberg. 1995. Gene Transfer to Plants, Springer Verlag, Germany.
4. Brown T A. 2010. Gene Cloning and DNA Analysis: An Introduction, 6th Edition, Blackwell publications, USA.
5. Christou P & Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.
6. Singh BD. 2007. Biotechnology: Expanding Horiozon. Kalyani.
7. Lewin's Genes XI 2012. Jones and Bartlett Learning, USA
8. U. Satyanarayana. Biotechnology, Book and allied (P), Ltd, 2013.

OPCGPB 711 GERMPLASM COLLECTION, EXCHANGE AND QUARANTINE (2+1)

Objective

- To provide information about collection, germplasm exchange, quarantine, maintenance and use of plant genetic resources including genetically modified plants.

Theory

Unit I - Introduction

History and importance of germplasm exploration; Distribution and extent of prevalent genetic diversity; Phyto-geographical regions/ecological zones and associated diversity; Mapping eco-geographic distribution of diversity, threatened habitats, use of flora.

Unit II - Mating System

Concept of population and gene pool; Variations in population and their classification; Gene frequencies in populations, rare and common alleles; Gene pool sampling in self and

cross pollinated and vegetatively propagated species; Non-selective, random and selective sampling strategies; Strategies and logistics of plant exploration and collection; Coarse and fine grid surveys; Practical problems in plant exploration; Use of *in vitro* methods in germplasm collection.

Unit III - Germplasm Collection

Ethnobotanical aspects of PGR; Crop botany, farming systems, collecting wild relatives of crop plants; Collection and preservation of specimens; Importance and use of herbaria and preparation of herbarium specimens.

Unit IV - Strategies in Collection of Germplasm

Post-exploration handling of germplasm collections; Present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, *Brassica*, okra, eggplant, cotton, mango etc; approaches for collection including indigenous knowledge.

Unit V - Plant Quarantine

History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange; Documentation and information management; Plant quarantine-introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India. Post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities; Domestic quarantine; seed certification; International linkages in plant quarantine; weaknesses and future thrust.

Practical

Plant exploration and collection; Techniques of coarse and fine grid surveys; Identification of wild relatives of crop plants- Example of collection, cataloguing and preservation of specimens; Sampling techniques of plant materials; Visiting ports, airports to study the quarantine regulations. Use of visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques(controlled green houses/growth chambers, etc); Study of post-entry quarantine operation, seed treatment and other prophylactic treatments.

Theory schedule

1. History and importance of germplasm exploration.
2. Distribution and extent of prevalent genetic diversity
3. Phyto-geographical regions/ecological zones and associated diversity
4. Mapping eco-geographic distribution of diversity.
5. Plant exploration and collection;
6. Concept of population and gene pool .
7. Coarse and fine grid surveys.
8. Gene pool sampling in self and cross pollinated and vegetatively propagated species.
9. Non-selective, random and selective sampling strategies.
10. Strategies and logistics of plant exploration and collection.
11. Practical problems in plant exploration.
12. *In vitro* methods in germplasm collection.
13. Ethnobotanical aspects of PGR.
14. Identification of wild relatives of crop plants.
15. Collection, cataloguing and preservation of specimens.
16. Post-exploration handling of germplasm collections.
17. **Mid-semester examination**
18. Present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum.

19. Present status and future strategies in collection of crops sesame, *Brassica*, okra, eggplant, cotton, mango.
20. History, principles, objectives and importance of plant introduction.
21. Documentation and information management
22. Importance and use of herbaria.
23. Preparation of herbarium specimens.
24. Sampling techniques of plant materials;
25. Plant quarantine- introduction, history, principles, objectives and relevance.
26. Regulations and plant quarantine set up in India.
27. Quarantine regulations.
28. Visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques.
29. Study of post-entry quarantine operation.
30. Seed treatment and other prophylactic treatments.
31. Domestic quarantine.
32. Seed certification.
33. International linkages in plant quarantine.
34. Weaknesses and future thrust in plant quarantine

Practical Schedule

1. Plant exploration and collection.
2. Handling of germplasm collections.
3. Preparation of herbarium specimens.
4. Identification of wild relatives of crop plants.
5. Techniques of coarse and fine grid surveys.
6. Identification of wild relatives of crop plants.
7. Example of collection.
8. Cataloguing of collection.
9. Preservation of specimens.
10. Sampling techniques of plant materials.
11. Visiting ports, airports to study the quarantine regulations.
12. Use of visual, microscopic, molecular and plant growth related techniques (controlled green houses/growth chambers, etc);
13. Qualitative and quantitative related techniques.
14. Study of post-entry quarantine operation.
15. Seed treatment and other prophylactic treatments.
16. Seed certification.
17. **Practical examination**

Outcomes

1. Students will have knowledge on the conservation of biodiversity
2. They will be able to identify the various *insitu* and *exsitu* conservation techniques
3. They will acquire knowledge on various organizations involved in conservation and their policies
4. The students will have knowledge on plant quarantine regulations.

CO-PO Mapping with POs of Agricultural Entomology

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

References

1. Briggs D. 1997. *Plant Variation and Evolution*. Science Publ.
2. Cronquist AJ. 1981. *An Integrated System of Classification of Flowering Plants*. Columbia Univ. Press.
3. Dhillon BS, Varaprasad KS, Kalyani S, Singh M, Archak S, Srivastava U & Sharma GD. 2001. *Germplasm Conservation A Compendium of Achievements*. NBPGR, New Delhi.
4. Di Castri F & Younes T. 1996. *Biodiversity Science and Development: Towards New Partnership*. CABI & International Union for Biol. Sci. France.
5. Gurcharan Singh. 2004. *Plant Systematics: An Integrated Approach*. Science Publ.
6. Lawrence GMH. (Ed.). 1951. *Taxonomy of Vascular Plants*. London.
7. Paroda RS & Arora RK. 1991. *Plant Genetic Resources Conservation and Management Concepts and Approaches*. IPGRI Regional office for South and South Asia, New Delhi.
8. Pearson LC. 1995. *The Diversity and Evolution of Plants*. CRC Press.
9. Singh BP. 1993. *Principles and Procedures of Exchange of Plant Genetic Resources Conservation and Management*. Indo-US PGR Project Management.
10. Sivarajan VV. 1991. *Introduction of Principles of Plant Taxonomy*. Science Publ.
11. Stace CA. *Plant Taxonomy and Biosystematics* 2nd Ed. Cambridge Univ. Press.
12. Takhrayan A. 1997. *Diversity and Classification of Flowering Plants*. Columbia Univ. Press.

OPC-GPB 712 FUNDAMENDALS OF GENETICS (2+1)

Objectives

The course imparts knowledge to the students about the structure organization, function and transmission of chromosomes and genes and variation among them, It explains the parallelism between the behaviour of chromosomes and genes. It is useful in construction of linkage map and location of genes. It also explains about the molecular genetics of gene organization and function: the effects of mutagens on biological system and evolution of crop plants.

Theory

Unit I - Cytology

Earlier concepts of heredity - cell and cell organelles - Prokaryotes - Eukaryotes - study of mitosis and meiosis - cell cycle - Sporogenesis - Gametogenesis - Fertilization.

Unit II - Mendelian Genetics

Mendel's work - laws of heredity - Multiple alleles - gene interaction - penetrance - Expressivity - Pleiotropy - Modifying genes - Phenocopy - lethal genes - Multiple Factor hypothesis.

Unit III - Linkages

Linkage and Crossing over - Estimation of strength of linkage and crossing over value - two and three point test cross - genetic map - sex determination - genic balance theory - Sex linked - sex influenced and sex limited inheritance - cytoplasmic inheritance.

Unit IV - Cytogenetics

Chromosomal theory of inheritance - chromosome structure - chemical composition and nucleosome - Types of chromosomes - special chromosomes - Mutation - point mutation - Transition and Transversion - Variation in chromosome number and structure - Aneuploidy and Euploidy - Its genetic and cytological implications.

Unit V - Genetic at Molecular Level

Experiments showing DNA as genetic material - DNA Structure and function - DNA replication - Genetic code - central dogma of life - gene expression - protein synthesis and gene regulation - Operon concept - modern concept of gene.

Practical

Study of genetic ratios of - Monohybrid, Dihybrid, Polyhybrid, inheritance - co-dominance - incomplete dominance, gene interactions. Multiple alleles and Multiple factors.

Study of linkage, estimation of strength of linkage and crossing over in two point and three point test cross - Drawing of genetic map - interference and coincidence. Preparation of fixatives and stains - Pretreatment of materials for mitosis and meiosis - Study of mitosis and meiosis.

Theory schedule

1. Concept of heredity - Vapour and fluid theory, Magnetic power theory, Preformation theory - Lamarck's theory, Darwin's theory, Germplasm theory and Mutation theory.
2. Definition of genetics, heredity and inheritance
3. Definition and Brief history of cytogenetics; structure and functions of cell and organelles - Difference between prokaryotes and Eukaryotes. Physical basis of heredity: Structure and function of cell and cell organelles - Differences between Prokaryotes and Eukaryotes.
4. Chromosome structure, chemical composition, nucleosome, centromere, telomere, euchromatin, NOR, satellite chromosome - karyotype, ideogram - types of chromosomes based on position of centromere.
5. Study of mitosis and meiosis - Cell cycle.
6. Work of Mendel - Characters studies, his observations and interpretation - reasons for his success - Law of dominance. Law of segregation and Law of independent assortment.
7. Rediscovery of Mendel's work, chromosomal theory of inheritance
8. Definitions of gene, alleles, homozygous, heterozygous, genome, phenotype, genotype, monohybrid, dihybrid, polyhybrid, backcross and test cross.
9. Lethal genes, Pleiotrophy with examples; phenocopy, penetrance and expressivity, Allelic interaction - Types - Complete dominance, incomplete dominance, Co-dominance and Over dominance with examples.
10. Non allelic interaction - epistatic and hypostatic genes, types of epistasis - Non - allelic interaction without modifications in Mendelian ratio - Bateson and Punnett's experiment on fowl comb shape.
11. Epistasis with modification of Mendelian ratio - 1) Dominant epistasis, ii) Recessive epistasis, iii) Duplicate and additive epistasis
12. iv) Duplicate dominant epistasis, v) Duplicate recessive epistasis vi) Dominant and recessive epistasis.
13. Multiple alleles - characteristic features, study of blood group, coat colour in rabbits and self incompatibility in plants.
14. Multiple factor hypothesis - Nilsson - Ehle - Wheat kernel colour experiment - polygenes - Transgressive segregation - Quantitative vs Qualitative characters and modifiers.
15. Linkage - coupling and repulsion - Experiment of Bateson and Punnett - Chromosomal theory of linkage of Morgan - Complete and incomplete linkage,
16. Crossing over - significance of crossing over - cytological proof for crossing over - Stern's experiment - Strength of linkage and recombination - Two point and three point test cross - Double cross over, interference and coincidence - genetic map.
17. **Mid-semester examination**
18. Sex determination - chromosomes mechanism of sex determination and its types - Genic balance theory of sex determination of Bridges.
19. Sex linked inheritance - Criss cross inheritance - reciprocal difference - Holandric genes - sex limited inheritance - sex determination in plants - *Melandrium*, papaya and maize.
20. Cytoplasmic inheritance - its characteristic features - examples of chloroplast, mitochondrial, plasmid and episomic inheritance.

21. DNA, the genetic material – Griffith's experiment, experiment of Avery, McCleod and McCarthy – confirmation by Hershey and Chase; RNA as genetic material – Frankel, Conrat and Singer experiment.
22. Structure of DNA – Watson and Crick model – mechanisms of DNA replication.
23. Models of DNA replication – Proof for semi-conservative method of DNA replication.
24. RNA types - mRNA, tRNA, rRNA; genetic code – Characteristic features – Central dogma of life.
25. Gene expression – protein synthesis.
26. Regulation of gene expression – operon model of Jacob and Monad; Structural genes and regulator genes.
27. Split genes, exons and introns – modern concept of gene – gene as cistron, muton and recon, complementation testy.
28. Special chromosomes – Polytene, Lamp brush. B. Ring and Iso chromosomes.
29. Variation in chromosome structure – deletion and duplication – genetic and cytological implications.
30. Inversion and translocation – genetic and cytological implications.
31. Variation in chromosome number – Euploid, aneuploid – types of euploids.
32. Polyploid – auto and allopolyploids.
33. Role of polyploidy in evolution of crops – wheat, cotton, tobacco and brassica
34. Types of aneuploids and their origin.

Practical Schedule

1. Principles of dominance, recessive, back cross, test cross, incomplets and co-dominance and lethal factor – principles of Chi-square test.
2. Study on genetic ratios – monohybrid – incomplete dominance and test cross ratios and in combination of one or two of the above.
3. Dihybrid ratio – dominance, incomplete dominance and test cross ration and in combination of one or two of the above.
4. simple interancetio of genes – comb character in fowls and Duplicate recessive epistasis.
5. Dominant epistasis and recessive epistasis.
6. Duplicate and additive epistasis. Duplicate dominant epistastis, duplicate recessive epistasis and dominant and recessive epistasis.
7. Multiple alleles and polygenec inheritance
8. Estimation of linkage with F2 and test cross data, coupling and repulsion
9. Problems on two point test cross.
10. Three point test cross – working out interference, coincidence and drawing genetic maps.
11. Principles of killing and fixing – preparation of stains and apreservatives
12. Studying the stages of mitosis and meiosis
13. Study of mitotic phases in roottips of onion / Aloe spa and Arabidopsis
14. Procedure for fixing and observing different moioticf phases in the inflorescence of Maize and peral millet.
15. Repeating the exercise
16. Repeating the exercise with Maize, Peral millet
17. Procedure for making temporary slides to permanent slides.

Course Outcomes

1. Students will acquire comprehensive understanding of the chemical basis of heredity.

2. The knowledge required to design, execute, and analyze the results of genetic experimentation in Plant Breeding systems
3. Critical understanding on quantification of heritable traits that provides insight into cellular and molecular mechanisms.
4. The ability to evaluate conclusions that are based on genetic data.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference books

1. Gupta P.K., 1997. Cytogenetics. Rastogi Publications, Meerut
2. Verma, P.S. and V.K. Agarwal. 2007. Genetics. S.Chand and Company Ltd./ New Delhi.
3. Stansfield, W.D. 1990. Theory and problems of genetics. Mc-Graw Hill Book Co., New York
4. Pundhan Singh. 2014. Elements of Genetics. Kalyani Publishers
5. Singh, B.D. 2004. Fundamentals of Genetics, Kalyani Publishers, Chennai
6. Benjamin Lewin. 2005. Genes IX Oxford University Press, Oxford.
7. Russel, P.J. 2000. Fundamentals of genetics. Addition Wesley Longman Publishers, USA
8. Daniel Sundararaj, G. Thulasidas and M. Stephen Dorairaj, 1997. Introduction to Cytogenetics and Plant Breeding. Popular Book Depot, Chennai -15.
9. Strickberger. M.W. 1996. Genetics. Prentice-Hall of India Pvt. Ltd. New Delhi.

OPCSST 711 SEED PRODUCTION TECHNIQUES IN CROPS (2+1)

Objective

- To introduce the basic principles of quality seed production

Theory

Unit I - Introduction

Introduction: Seed as basic input in agriculture; Seed multiplication ratios-seed replacement rate, generation system of seed multiplication; variety and causes for its deterioration;

Unit II - Principles

Mode of pollination and reproduction in crop plants and their modification in relation to hybrid seed production. Principles of hybrid seed production, isolation distance, synchronization of flowering, roguing etc. male sterility and incompatibility system in hybrid seed production, role of pollinators and their management.

Unit III - Classes of seeds and their production techniques

Seed multiplication ratio-seed replacement rate, demand and supply; suitable areas of seed production and storage, agronomy of seed production- agro climatic requirements and their influence on quality seed production; generation system of seed multiplication; maintenance of nucleus seed, production of breeder, foundation and certified seed - criteria involved; life span of a variety and causes for its deterioration; certification standards for self, cross and often cross pollinated and vegetatively propagated crops.

Unit IV - Hybrid seed production

Hybrid seed - methods of development ; use of male sterility, self- incompatibility and CHA in hybrid seed production; one, two and three line system; maintenance of parental

lines of hybrids; planning and management of hybrid seed production technology of major field crops

Unit V - Seed quality control

Planning of seed production for different classes of seeds for self, cross and often cross pollinated crops, seed quality control system and organization, seed village concept; seed production agencies, seed industry and custom seed production in India

Theory schedule

1. Seed basic input in agriculture
2. Importance and characteristic of quality seed
3. Different types of cultivars and their maintenance
4. Difference between seed and grain, seed production and crop production
5. Varietal deterioration their maintenance- factors responsible for deterioration
6. Maintenance of genetic purity in seed production
7. Pollination and reproduction techniques and their modifications in relation to hybrid seed production
8. Principles of hybrid seed production- isolation distance-synchronization of flowering, rogueing etc.
9. Seed multiplication ratios and seed replacement rate
10. Agronomy of seed production- agro-climatic requirements and their influence on quality seed production
11. Generation system of seed multiplication- maintenance of nucleus and breeder seed
12. Floral structure, breeding and pollination mechanism in cross-pollinated cereals and millets.
13. Methods and techniques of quality seed production in cross-pollinated crop -Rice
14. Methods and techniques of quality seed production in cross-pollinated crop - Maize
15. Methods and techniques of quality seed production in -Sorghum
16. Methods and techniques of quality seed production in-Bajra.
17. **Mid semester examination**
18. Methods and techniques of quality seed production in pigeonpea.
19. Methods and techniques of quality seed production in Chickpea
20. Methods and techniques of quality seed production in greengram
21. Methods and techniques of quality seed production in blackgram
22. Methods and techniques of quality seed production in soyabean.
23. Methods and techniques of quality seed production in cowpea
24. Floral structure, breeding and pollination mechanism in Oilseeds.
25. Methods and techniques of quality seed production in groundnut.
26. Methods and techniques of quality seed production in castor.
27. Methods and techniques of quality seed production in sunflower
28. Methods and techniques of quality seed production in sesame
29. Methods and techniques of quality seed production in cotton.
30. Methods and techniques of quality seed production in Sugarcane.
31. Seed quality control system and organizations
32. Genetic purity testing- GOT
33. Seed village concept
34. Seed production agencies, seed industry and customs in India

Practical Schedule

1. & 2. Identification of seed structure of agricultural crops
2. Visit to seed production unit
3. Hybrid seed production techniques in agricultural crops

4. Planting design and identification of rogues and off types in varieties and hybrids of agricultural crops
5. Study of supplementary pollination and pollen management techniques in agricultural crops.
6. Identification of physiological maturity for agricultural crops
7. Influence of grading techniques on seed quality characters.
8. Planning seed production for different classes of seeds in varieties of agricultural crops
9. Planning seed production for different classes of seeds in varieties of horticultural crops
10. Visit to seed production field and processing unit
11. Visit to private seed industry
12. Seed enhancement techniques
13. Detasseling in maize
14. Identification of rogues and pollen shedders
15. Gametocide application for hybrid seed production
16. **Practical Examination.**

Course Outcomes

1. To really understand the basic principles of seed production in varieties and hybrids
2. To know the concept of and methods of hybrid seed production
3. To understand the importance of field standards and seed standards in quality seed production

CO-PO Mapping with POs of Agricultural Entomology

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

References

- Agarwal, R.L. 1997. Seed Technology. 2nd Ed. Oxford & IBH, New Delhi.
- Desai, B.B., Katecha, P.M. & Salunke, D.K.1997. Seed Hand Book: Biology, Production, Processing and Storage. Marcel Dekker, New York.
- Kelly, A.F. 1988. Seed Production of Agricultural Crops. John Wiley, New York.
- McDonald, M.B. & Copeland, L.O. 1997. Seed Production: Principles and Practices. Chapman & Hall, New York.
- Singhal, N.C. 2003. Hybrid Seed Production in Field Crops. Kalyani Publishers, New Delhi.

OPCSST 712 SEED QUALITY TESTING AND CERTIFICATION (2+1)

Objective

- To provide a comprehensive knowledge on all aspects of seed quality evaluation and their relevance to crop performance.

Theory

Unit I - History of Seed Testing

Introduction: Structure of monocot and dicot seeds; seed quality: objectives, concept and components and their role in seed quality control; Instruments, devices and tools used in seed testing. ISTA and its role in seed testing. Seed Sampling sampling in the seed testing laboratory.

Unit II - Testing for purity and Moisture

Physical Purity: definition, objective and procedure, weight of working samples for physical purity analysis; components of purity analysis and their definitions and criteria;

pure seed definitions applicable to specific genera and families; multiple seed units; general procedure of purity analysis; calculation and reporting of results, prescribed seed purity standards; determination of huskless seeds

Unit III - Germination, Vigour and Viability testing Test for Genetic purity

Germination: importance; definitions; requirements for germination, instrument and substrata required; principle and methods of seed germination testing; dormancy: definition, importance, causal mechanisms, types and methods for breaking dormancy. Viability and Vigour Testing: definition and importance of viability tests; different viability tests; quick viability test (TZ- test) - advantages, principle, preparation of seeds and solutions, procedure, evaluation and calculation of test results. Vigour testing: Genetic purity testing : objective and criteria for genetic purity testing; types of test; laboratory

Unit IV - Seed legislation in India

Seed legislation and seed law enforcement as a mechanism of seed quality control; The Seed Act (1966), Seed Rules (1968), Seed (Control) Order 1983; Essential Commodities Act (1955); Plants, Fruits and Seeds Order (1989); National Seed Development Policy (1988) and EXIM Policy regarding seeds, plant materials; New Seed Bill-2004. Introduction, objectives and relevance of plant quarantine, regulations and plant quarantine set up in India.

Unit V - Seed Certification aspects

Seed Certification- history, concept and objectives of seed certification; seed certification agency/organization and staff requirement; legal status and phases of seed certification; formulation, revision and publication of seed certification standards; Indian Minimum Seed Certification Standards (I.M.S.C.S.)- general and specific crop standards including

Theory Schedule

1. Seed quality: objectives, concept and components
2. Instruments, devices and tools used in seed testing
3. National and International agencies involved in seed testing
4. ISTA and its role in seed testing.
5. Seed Sampling: definition, objectives and procedure
6. Physical Purity analysis
7. Seed moisture content: importance, principles and methods of moisture estimation
8. Germination: importance; definitions; types - requirements for germination,
9. Methods of seed germination testing for agricultural crops
10. Methods of seed germination testing for horticultural crops
11. Seedling evaluation, calculation and reporting of results for agricultural crops
12. Seedling evaluation, calculation and reporting of results for horticultural crops
13. Dormancy: definition, importance, causal mechanisms, types
14. Methods for breaking dormancy.
15. Quick viability test (TZ- test) - advantages, principle.
16. Vigour testing: concept, historical development, definitions
17. **Mid Semester examination**
18. Procedures of different methods used for testing vigour.
19. Genetic purity testing : objective, types of test
20. Historical development of Seed Industry in India
21. Seed quality: concept and factors affecting seed quality during different stages of production
22. Seed quality control- concept and objectives
23. Central Seed Certification Board and its function
24. Organizations involved in seed quality control programmes
25. The Seed Act (1966) and Seed Rules (1968)
26. The Seed (Control) Order 1983 and Essential Commodities Act (1955)

27. EXIM Policy regarding seeds, plant materials and New Seed Bill-2004 etc.
28. Introduction, objectives and relevance of plant quarantine.
29. Seed Certification- history, concept and objectives of seed certification
30. Indian Minimum Seed Certification Standards (I.M.S.C.S.)- general and specific crop standards
31. Field Inspection- principles, phases and procedures
32. Pre and post-harvest control tests for genetic purity evaluation (grow-out tests)
33. Post harvest inspection and evaluation
34. Essential features of PPV & FR Act, 2001

Practical Schedule

1. Identification and handling of instruments used in seed testing laboratory
2. Seed sampling and sampling procedure
3. Physical purity analysis of samples of different crops
4. Estimation of seed moisture content (oven method)
5. Seed dormancy breaking methods
6. Seed germination testing in different agri-horticultural crops
7. Seedling evaluation
8. Viability testing by tetrazolium test in different crops
9. Seed vigour tests
10. Grow out test
11. Varietal identification through electrophoresis
12. Visit to Seed Testing laboratory
13. General procedure of seed certification
14. Field inspection at different stages of a crop and observations recorded on contaminants and reporting of results.
15. Field counting procedure for different crops
16. Preparation of Field Inspection report
17. **Final Practical examination**

Course Outcomes

1. To have a faith in seed certification procedure and importance of IMSCS
2. To sort out the rogues and off types from the seed production area and to understand the importance of seed testing
3. Will be in a position to emphasis on Seed Legislation, certification, labelling of different seed classes and truthfully labelled seeds

CO-PO Mapping with POs of Agricultural Entomology

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

References

1. Agarwal, R.L. 1997. Seed Technology. Oxford & IBH, New Delhi.
2. Agrawal, P.K. & Dadlani, M.1992. Techniques in Seed Science and Technology. 2nd Ed. South Asian Publishers, New Delhi.
3. Agrawal, P.K. (Ed.). 1993. Handbook of Seed Testing. Ministry of Agriculture, GOI, New Delhi.
4. Copland, L.O. & McDonald, M.B. 1996. Principles of Seed Science and Technology. Kluwer Academic Publishers, New York.
5. ISTA, 2006. Seed Testing Manual. ISTA, Switzerland.
6. Martin, C. & Barkley, D. 1961. Seed Identification Manual. Oxford & IBH, New Delhi.

7. Tunwar, N.S. & Singh, S.V. 1988. Indian Minimum Seed Certification Standards. Central Seed Certification Board, Ministry of Agriculture, New Delhi.
8. Agarwal, R.L. 1997. Seed Technology. Oxford & IBH, New Delhi.
9. Nema, N.P. 1986. Principles of Seed Certification and Testing. Allied Publishers, New Delhi.

OPCHOR 711 PROPAGATION AND NURSERY MANAGEMENT OF HORTICULTURAL CROPS (2+1)

Objectives

This course deals with different methods of plant propagation and strategies for nursery management of various fruit crops. Knowledge of tools and implements is essential to carry out all scientific horticultural operations and also nursery management practices. The above themes are discussed elaborately in this course and the basic knowledge gained will be useful for the career development of students in commercial nursery business.

Theory

Unit I Principles of plant propagation

Sexual and asexual methods of propagation - principles and factors influencing seed germination-dormancy- hormonal regulation of germination and seedling growth- seed quality- packing- storage- certification and testing.

Unit II Anatomical and physiological aspects of plant propagation

Techniques of cottage - layerage- graftage and budding- compatibility- dwarfing rootstocks of important fruit trees.

Unit III Plant growth regulators and plant tissue culture

Role of PGR'S in plant propagation- role of nucellar embryony- apomixes- tissue culture techniques- hardening techniques .

Unit IV Planning of a nursery unit and modern propagation structures

Raising of nursery plants- selection- certification maintenance of mother plants and bud wood and root stock nurseries- use of modern structures- mist chambers- low cost poly houses- tunnel houses.

Unit V Marketing methods of nursery plants and economics

Media/soil mixtures- containers- use of machineries- lifting- packing- transport-marketing- economics of raising nursery and management in different fruit crops.

Practical

Media/soil mixture- containers and soil sterilisation- use of chemicals for seed treatment and sowing- preparation of nursery beds- polybags- seedpans- thumb rule for raising seedlings- stratification and scarification of seeds and use of tetrazolium salts for germination tests-identification of nucellar seedlings- practice of different asexual methods of propagation- viz.-cuttage- layering- budding- approach- veneer and softwood grafting- use of plant growth regulators in propagation of plants -use of mist chambers- modern propagation structures- low cost polyhouses- low tunnels and bottom heating techniques- selection- lifting- packing- transportation and marketing of nursery plants- economics of raising nurseries- visit to local commercial/private nurseries.

Lecture schedule

1. Scope and importance of plant propagation.
2. Study of sexual and asexual methods of propagation.
3. Advantages and disadvantages of seed and vegetative propagation.
4. Factors influencing seed germination of Horticultural crops.
5. Studies on dormancy, hormonal regulation of germination and seedling growth.
6. Study of seed quality, packing, storage, certification and testing.
7. Study of anatomical and physiological aspects of asexual propagation.
8. Studies on graft compatibility on fruit crops.
9. Dwarfing rootstocks of commercial importance in fruit crops.

10. Role of PGR's in raising seedlings and rooting of cuttings and layers.
11. Role of nucellar embryony and apomixis.
12. Studies on tissue culture techniques.
13. Micro grafting (STG).
14. Techniques of cuttings and layering.
15. Techniques of budding and grafting.
16. Planning of nursery unit.
17. **Mid-semester examination**
18. Study of raising of nursery plants and their after care- role of protray nursery and their after care.
19. Study of modern propagation structures.
20. Role of mist chambers in plant propagation.
21. Study of bottom heating techniques.
22. Hardening techniques in nursery.
23. Progeny orchard and scion bank.
24. Establishment of bud wood bank.
25. Media -soil mixture preparation for nursery plants.
26. Study of containers used for nursery.
27. Use of machineries in nurseries.
28. Soil sterilization techniques.
29. Irrigation systems in nursery plants.
30. Lifting and packing of nursery plants.
31. Transportation and marketing of nursery plants.
32. Nursery planning and layout .
33. Economics of raising nursery and management of different fruit crops.
34. Nursery acts.

Practical schedule

1. Media/soil mixture, containers and soil sterilization.
2. Use of chemicals for seed treatment and sowing.
3. Preparation of nursery beds, polybags, seedpans, thumbrule for raising seedlings.
4. Stratification and scarification of seeds and use of tetrazolium salts for germination.
5. Identification of nucellar seedlings.
6. Practice of different asexual methods of propagation, viz.,cuttage, layering.
7. Buddingmethods.
8. Grafting- methods.
9. Use of plant growth regulators in propagation.
10. Role of mist chambers in plant propagation.
11. Other protected structures uses for plant propagation.
12. Low cost polyhouses, low tunnels.
13. Bottom heating techniques and soil sterilization.
14. Selection, lifting, packing of nursery plants.
15. Transportation and marketing of nursery plants.
16. Economics of raising nurseries.
17. Visit to local commercial/private nurseries.

Course Outcomes

CO1- gain knowledge on physiology, principles, factors influencing, media and methods of propagation of Horticultural crops

CO2-gain skill in all propagation methods and technology for commercial scale adoption

CO3- becomes capable of managing commercial nursery business.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference books

1. Adams, C.R., K.M. Bandford and M.P. Early. 1996. Principles of Horticulture CBS Publishes and Distributors, New Delhi.
2. Bose, T.K., S.K. Mitra., M.K. Sadhu and B. Mitra. 1991. Propagation of Tropical and subtropical Horticultural Crops, Naya Prokash, Calcutta. India.
3. Edmond, J.B., T.L. Senna., F.S. Andrews and R.R. Halfacre. 1990. Fundamentals of Horticulture. Tata McGraw Hill Publishing Co. Ltd.
4. Hartmann, H.T., D.E. Kester., F.T. Davies. and R.L. Greneve. 1997. Plant propagation - Principles and Practices, Prentice Hall of India Private Ltd., New Delhi.
5. Prasad, S. and V. Kumar. 1999. Green House Management of Horticultural Crops, AgroBios India, Jodhpur.
6. Reddy, Y.T.N., T. Janakiram. and D. Satyanarayana Reddy. 2001. Scientific Nursery Management, The House of Sarpan (Media), Bangalore.

OPC - FSC 712 GENETIC RESOURCES AND CONSERVATION OF FRUIT CROPS (2+1)

Objectives

Understanding the principles of biodiversity, strategies in conservation and utilization of fruit crop biodiversity and learning about under exploited fruits in India.

Theory

Unit I Importance of biodiversity and methods of conservation

Biodiversity and conservation- issues and goals- centers of origin of cultivated fruits- primary and secondary centers of genetic diversity- present status of gene centers- exploration and collection of germplasm- conservation of genetic resources- *in situ* and *ex situ* germplasm conservation- problem of recalcitrancy- cold storage of scions- tissue culture- cryopreservation- pollen and seed storage- inventory of germplasm.

Unit II Role of National institutes in conservation and plant quarantine

Introduction of germplasm- plant quarantine- role of National institutes in conservation- TBGRI- NBPGR.etc- Intellectual property rights- regulatory horticulture- plant variety protection authority- maintenance of core group using traditional knowledge for plant conservation.

Unit III Bio diversity of tropical fruit crops

Biodiversity of major tropical fruit crops - Mango- banana- sweet orange- lime- lemon- sapota- papaya- guava- pomegranate- pineapple- annona and avocado.

Unit IV Bio diversity of sub tropical and temperate fruit crops

Biodiversity of major sub tropical- temperate fruit and nut crops - grapes- mandarin- mangosteen- litchi- fig- apple- pear- plum- peach- strawberry- almond- apricot and walnut.

Unit V Bio diversity of under exploited minor fruit crops

Under exploited minor fruits -present status and scope- their origin- distribution- biodiversity- conservation and utilization of minor fruits.

Practical

Documentation of germplasm maintenance of passport data and other records of accessions; field exploration trips- exercise on *ex situ* conservation cold storage- pollen/seed storage- cryopreservation- visits to National Gene Bank and other centers of PGR activities.

Lecture schedule

1. Bio diversity - introduction, principles, goals and issues in conservation.
2. Genetic diversity- occurrence and distribution.
3. Exploration, collection, characterization, documentation and cataloguing of germplasm.
4. Present status of National and International gene banks.
5. Role of national institutes in conservation-TBGRI, NBPGR.etc.
6. Germplasm exchange, Material Transfer Agreement and current quarantine protocols.
7. Methods for *ex situ* conservation of germplasm and *in situ* conservation of germplasm.
8. Use of GIS and documentation of local biodiversity.
9. Horticultural cropping systems and implication on biodiversity .
10. Impact of climate change on biodiversity.
11. Advances and issues in conservation of biodiversity though recalcitrant and orthodox seeds.
12. Advances and issues in conservation of biodiversity through vegetative propagation.
13. Intellectual Property Rights, Plant Variety Protection Authority .
14. Status of biodiversity of mango.
15. Status of biodiversity of banana.
16. Status of biodiversity of sweet orange, lime and lemon.
17. **Mid-semester examination**
18. Status of biodiversity of sapota and papaya.
19. Status of biodiversity of guava and pomegranate.
20. Status of biodiversity of pineapple and annona.
21. Status of biodiversity of avocado and mangosteen.
22. Status of biodiversity of grapes.
23. Status of biodiversity of mandarin .
24. Status of biodiversity of litchi and fig.
25. Status of biodiversity of apple and pear.
26. Status of biodiversity of plum and peach.
27. Status of biodiversity of strawberry .
28. Status of biodiversity of almond and apricot.
29. Status of biodiversity of walnut.
30. Under exploited minor fruit crops - present status and scope
31. - 34. Minor fruits - origin, distribution - biodiversity, propagation, conservation and utilization.

Practical schedule

1. Field exploration trips- exercise in collection and characterization
2. Visit to field germplasm unit and documentation of germplasm
3. Practices in maintenance of passport data
4. Practical study of *ex situ* conservation methods
5. Practical study of *in situ* conservation methods
6. Methods of seed storage for short and long term conservation
7. Methods of conservation using vegetative propagules
8. *In vitro* conservation protocols
9. Study of species diversity in horticultural cropping system

10. Visit to regional conservation centres
11. Visit to subtropical and temperate zone orchards
12. Characterization of banana germplasm
13. Characterization of papaya germplasm
14. Characterization of mango germplasm
15. Identification of minor fruit crops and their description.
16. Use of molecular tools for characterizing species diversity
17. Estimating extent of diversity through collection and analysis of data

Course Outcomes

CO1:The students will be able to understand the strategies in conservation and utilization of fruit crop biodiversity

CO2:They will be able to demonstrate different techniques in *ex-situ* conservation.

CO3:They will be able to identify underutilized minor fruit crops.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference books

1. Frankel, O.H. and J.G. Hawkes. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.UK
2. Peter, K.V. and Z. Abraham. (Eds). 2007. Biodiversity in Horticultural Crops.Vol.1 Daya Publishers, New Delhi
3. Peter, K.V. (Ed).2008. Biodiversity in Horticultural Crops.Vol.2 Daya Publishers, New Delhi
4. Peter, K.V (Ed).2010. Biodiversity in Horticultural Crops.Vol.3 Daya Publishers, New Delhi

OPC VSC 712 HI - TECH VEGETABLE PRODUCTION (2+1)

Objectives

To impart latest knowledge in growing of vegetable crops under protected environmental conditions.

Theory

Unit I Importance, scope and principles of Hi-tech vegetable production

Importance and scope of protected cultivation of vegetable crops. principles used in protected cultivation- energy management- low cost structure- training methods- engineering aspects.

Unit II Environmental factors and its manipulation for vegetable production

Types of green house- poly house/ net house hot- cold framers- effect of environmental factors viz temp- light - co₂ and humidity on growth of different vegetables- manipulation of co₂- and temperature for vegetable production.

Unit III Green house media- containers- heating and cooling systems

Growing media and sterilization- soilless cultivation- hydro-ponics and aero ponics- types of benches and containers irrigation and fertigation- green house environmental control systems- cooling system- heating system light and photo period manipulation.

Unit IV Techniques of raising vegetables in protected structures

Regulation of flowering and fruting in vegetable crops. technology for raising tomato- sweet pepper- cucumber and other vegetables in protected structures- training and staking in protected crops- varieties and hybrids for growing vegetables in protected structures.

Unit V Problems and remedies in Hi-tech cultivation

Problem of growing vegetables in protected structures and their remedies- insect and disease management in protected structures- soil-less culture- use of protected structures for seed production.

Practical

Study of different protected structures- cladding materials used- installation and their management study of environment control devices used in protected structures measurement of temperature- RH- light and CO₂ study of growing media and sterilization- study of irrigation and fertigation systems and their management- soilless cultivation- hydroponics and aeroponics- control of insect pest and disease in green house -working out economics of protected cultivation visit to established green/poly house/net/shade house in the region.

Lecture schedule

1. History of protected cultivation of vegetables and its scope in India.
2. Present status of Hi-tech cultivation and its importance.
3. Principles involved in Hi-tech vegetable cultivation.
4. Modes of protected cultivation.
5. Nursery raising in protected structures.
6. Low - cost protected structures.
7. Site selection, structural designs, styles single span, multi-span.
8. Effect of environmental factors on the growth of vegetables.
9. Manipulation of CO₂, light and temperature for vegetable production
10. Green house roofing materials.
11. Green house media, natural and synthetic and sterilization.
12. Soilless cultivation, Hydroponics and Aeroponics.
13. Green house beds and benches construction and space use efficiency.
14. Green house temperature control, heating, cooling and lighting.
15. Cooling methods, ventilations, evaporative cooling and air conditioning.
16. Types of irrigation in green house, purpose and advantage.
17. **Mid-semester examination.**
18. Fertigation of vegetable crops under protected cultivation.
19. Pruning of vegetable crops under protected structure.
20. Training, staking and other operations under Hi-tech vegetable production.
21. Regulation of flowering and fruiting of vegetable crops.
22. Hi tech production of tomato.
23. Hi tech production of sweet pepper.
24. HI tech production of cucumber and other vegetables.
25. Hi tech production of exotic vegetables.
26. Suitable varieties and hybrids for growing vegetables in protected structures.
27. Problems in Hi-tech cultivation and remedies.
28. Insect and disease management in protected structures.
29. Use of protected structures for seed production.
30. Precision Horticulture, principles and concepts.
31. GPS, GIS remote sensing sensors.
32. Variability management in precision farming, mapping, variable rate technology.
33. Precision equipments, computers and robotics in precision farming.
34. Cost - economics of Hi-tech vegetable production.

Practical schedule

1. Study of various modes of protected cultivation.
2. Study of environment control devices used in protected structures.
3. Study of growing media and sterilization.
4. Study of irrigation and Fertigation systems.

5. Study of soilless cultivation, Hydroponics and Aeroponics.
6. Estimating the cost of low cost green house of IARI model.
7. Designing of covering materials.
8. Designing of cooling systems.
9. Designing of irrigation system.
10. Control of insect pest and disease in green house.
11. Economics of green house cultivation of tomato.
12. Economics of green house cultivation of sweet pepper.
13. Economics of green house cultivation of cucumber.
14. Visit to established green/poly house/ net/ shade house in the region.
15. Visit to export oriented vegetable units.
16. Visit to precision farming unit.
17. Visit to GPS, GIS and remote sensing facility.

Course Outcomes

CO1: The students will be able to demonstrate working principles of protected cultivation.

CO2: The students will be able to establish and manage Hi-Tech vegetable production units.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference books

1. Aldrich, R.A. and K.W. Bartok. 1994. Green house Engineering, NRAE, Riley, Robb Hall, Cornell University, Ithaca, New York.
2. Paul.V Nelson 1991. Green house operation and Management. Ball Publishing, USA.
3. Pranab Hazya, A., Chattopadyay, K. Karmakar and S. Dutta. 2011. Modern technology in vegetable production. New India Publishing Agency, New Delhi.
4. Prasad, S. and U. Kumar. 2005. Green house management for Horticultural crops. 2nd ed. Agrobios, Jodhpur.
5. Tiwari Gn. 2003. Green house technology for controlled environment. Narosa Publ.House

OPC-FLA 712 ORNAMENTAL HORTICULTURE (2+1)

Objectives

Familiarization with principles and practices of landscaping and ornamental gardening.

Theory

Unit I Ornamental horticulture- History and principles

Ornamental horticulture-definition- scope and importance- history of ornamental horticulture. types of gardens. styles of garden- formal- informal and free style gardens. beauty components- basic principles of gardening.

Unit II Softscape and Hardscape elements

Garden plant components-basic function and utility- arboretum- shrubbery- fernery- palmatum- edges and hedges -topiary and trophy- climbers and creepers- cacti and succulents- herbs- annuals- flower borders and beds- ground covers- carpet beds- bamboo groves; lawns- establishment and maintenance- production technology for selected ornamental plants .non-plant components.

Unit III Special types of gardens and horticultural crafts

Special types of gardens- vertical garden- roof garden- bog garden- sunken garden- rock garden- clock garden- temple garden and sacred groves. Study on horticultural crafts- bonsai- terrarium and flower arrangement-

Unit IV Landscape drawing

Site analysis- client preference- home- institute- industrial garden- public parks- amusements and theme parks- landscape drawing- fundamentals of manual drawing- scale- symbols- layout- plan view- elevation and perspective diagrams- computer software- manual and computer aided designing- applications of CAD in landscape garden designing.

Unit V Landscaping for specific situations

Urban landscaping- landscaping for specific situations- hospitals- roadsides- traffic islands- damsites- it parks- corporates. bio-aesthetic planning- eco-tourism- indoor gardening- therapeutic gardening- water scaping and xeriscaping.

Practical

Identification of ornamental plants and garden components- study of form- size- shape- texture- flowering season and description of trees- shrubs- flower bed- foliage bed- climbers and creeper- hedges- edges cacti- succulents- ferns and palms- evaluation of different styles of garden- turf- study of types of turf grasses- establishment- care and maintenance of turf- art of topiary- practices in planning and planting of special types of gardens- identification- planning and designing of non-living components- principles and concepts in garden designing- techniques in transplanting of container grow plants- burlapping- tree transplanting- preparation of landscape plan layout- application of cad in landscape garden designing- project preparation on landscape execution for home- institute- industrial- public parks and theme parks. study on horticultural crafts- bonsai- terrarium and flower arrangement- visit to parks and botanical garden.

Lecture Schedule

1. Ornamental horticulture-Definition, scope and importance.
2. History of ornamental horticulture,
3. Types of gardens.
4. Styles of garden, formal, informal and free style gardens
5. Beauty components
6. Basic principles of gardening.
7. Garden plant components, arboretum,
8. Shrubbery, fernery, palmatum, edges and hedges,
9. Climbers and creepers, cacti and succulents and herbs,
10. Annuals, flower borders and beds,
11. Ground covers, carpet beds and bamboo groves,
12. Lawns, Establishment and maintenance,
13. Production technology for selected ornamental plants.
14. Non-plant components-basic function and utility.
15. Special types of gardens, vertical garden and roof garden,
16. Bog garden, sunken garden and rock garden,
17. **Mid semester examination.**
18. Clock garden, temple garden, sacred groves.
19. Study on horticultural crafts, bonsai and terrarium.
20. Flower arrangement,
21. Site analysis, client preference,
22. Home, institute and industrial garden,
23. Public parks, amusements and theme parks,
24. Landscape drawing, fundamentals of manual drawing, scale, symbols and layout,
25. Plan view, elevation and perspective diagrams,

26. Computer software, manual and computer aided designing, applications of CAD in landscape garden designing.
27. Urban landscaping,
28. Landscaping for specific situations, residents, hospitals, roadsides and traffic islands,
29. Damsites, IT parks and corporates.
30. Bio-aesthetic planning,
31. Eco-tourism and theme parks
32. Indoor gardening,
33. Therapeutic gardening,
34. Water scaping and xeriscaping.

Practical schedule

1. Identification of ornamental plants and garden components.
2. - 5. Study of form, size, shape, texture, flowering season and description of trees, shrubs, flower bed, foliage bed, climbers and creeper, hedges, edges cacti, succulents, ferns and palms.
3. Evaluation of different styles of garden.
4. Turf - study of types of turf grasses - establishment, care and maintenance of turf.
5. Art of topiary -
6. Practices in planning and planting of special types of gardens.
7. - 11. Identification, planning and designing of non-living components.
8. Techniques in transplanting of container grown plants, burlapping, tree transplanting.
9. Principles and concepts in garden designing.
10. Manual preparation of landscape plan layout.
11. Application of CAD in landscape garden designing.
12. Project preparation on landscape execution for home, institute, industrial, public parks and theme parks.
13. Study on horticultural crafts, bonsai, terrarium and flower arrangement. Visit to parks and botanical garden

Course Outcomes

CO1: The students will be able to demonstrate working principles of protected cultivation.

CO2: The students will be able to establish and manage Hi-Tech vegetable production units.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference Books

1. Beard, J.B. 1973. Turfgrass: Science and Culture. Agro Botanica. Jodhpur.
2. Bose, T.K., R.G. Maiti, R.S. Dhua. and P. Das. 1999. Floriculture and Landscaping. NayaProkash, Kolkatta.
3. Brain Closton. 1984. Landscape design with plants. Van Nostrad Reinhold company NewYork.
4. Gopaldasamy Iyyankar. 1970. Complete Gardening In India. Kalyan Printers, Bangalore.
5. Hari Krishna Pahiwal. 2009. Ornamental gardening. National Book Trust, New Delh.
6. Karuppaiah, P. and K. Manivannan. 2017. Ornamental Horticulture. Agrobios, Jodhpur.

7. Lancaster, P. 1991. Gardening in India, Oxford and IBH Publishing Co. (P) Ltd. Kolkatta.
8. Nambisan, K.M.P. 1992. Design Elements of Landscape Gardening, Oxford and IBH Publishing Co. (P) Ltd. Kolkatta.
9. Sabina, G.T. and K.V. Peter. 2008. Ornamental Plants for Gardens. New India Publ., New Delhi.
10. Valsalakumari, P.K., P.K. Rajeevan, P.K. Sudhadevi and C.K. Geetha. 2008. Flowering Trees. New India Publ., New Delhi.

OPC-PSM 712 GENETIC RESOURCES AND CONSERVATION OF MEDICINAL AND AROMATIC PLANTS (2+1)

Objectives

Understanding the principles of biodiversity- strategies in conservation and utilization of medicinal and aromatic plants- Biodiversity and learning about under exploited medicinal and aromatic plants in India.

Theory

Unit I Importance of biodiversity and methods of conservation

Biodiversity & conservation- issues and goals- centres of origin of cultivated medicinal and aromatic plants- primary and secondary centres of genetic diversity- present status of gene centers- exploration and collection of germplasm- conservation of genetic resources *in-situ* & *ex-situ* germplasm conservation problem of recalcitrant seeds cold storage of scions- tissue culture cryopreservation- pollen and seed storage inventory of germplasm.

Unit II Role of National institutes in conservation of plant quarantine

Introduction of germplasm- plant quarantine- role of knowledge, role of national institutes is conservation- TBGRI- NBPGR. intellectual property rights- regulatory horticulture- plant variety protection authority- maintenance of core group using rational knowledge for plant conservation.

Unit III Bio diversity of medicinal plants -I

Senna- coleus- ashwagandha- glory lily- sarpagandha- dioscorea sp. aloevera- phyllanthus

Unit IV Bio diversity of medicinal plants -II

Kalmegh- medicinal solanum- gymnema- isabgol- ipecac- periwinkle- poppy- safed musli- stevia

Unit V Aromatic plants

Palmarosa- lemongrass- citronella- vetiver- geranium- mentha- artemisia- ocimum- eucalyptus- rosemary- thyme- patchouli- lavender- marjoram- oreganum.

Practical

Documentation of germplasm maintenance of passport data and other records of accessions; field exploration trips- exercise on *ex situ* conservation; cold storage- pollen/seed storage- cryopreservation- visit to National Gene Bank and other centers of PGR activities.

Lecture schedule

1. Bio diversity - introduction- principles, goals and issues in conservation
2. Genetic diversity- occurrence and distribution
3. Exploration, collection, characterization, documentation and cataloging of germplasm
4. Present status of national and international gene banks
5. Role of national institutes in conservation-TBGRI, NBPGR.
6. Germplasm exchange, Material Transfer Agreement and current quarantine protocols
7. Methods for *ex situ* conservation of germplasm and *in situ* conservation of germplasm

8. Use of GIS and documentation of local biodiversity
9. Horticultural cropping system and implication on biodiversity
10. Impact of climate change on biodiversity
11. Advances and issues in conservation of biodiversity through recalcitrant and orthodox seeds
12. Advances and issues in conservation of biodiversity through vegetative propagation
13. Intellectual Property Rights, Plant Variety Protection Authority
14. Status of biodiversity of coffee
15. Status of biodiversity of tea, cashew
16. Status of biodiversity of cocoa, rubber, palmyrah, oil palm, coconut and arecanut.
17. **Mid-semester examination**
18. Status of biodiversity of black pepper and cardamom
19. Status of biodiversity of ginger and turmeric
20. Status of biodiversity of coriander and fennel
21. Status of biodiversity of nutmeg and cinnamom
22. Status of biodiversity of Clove
23. Status of biodiversity of Aloe vera
24. Status of biodiversity of *Coleus forskohlii* and *Dioscorea sp.*
25. Status of biodiversity of *Ocimum* and *Phyllanthus amarus*
26. Status of biodiversity of Geranium and Vettiver
27. Status of biodiversity of Lemon grass
28. Status of biodiversity of Palmrosa and Citronella
29. Status of biodiversity of Eucalyptus, Artemisia and Mint.
30. Under exploited minor fruit crops - present status and scope
31. - 34. Minor spices and Plantation crop - origin, distribution - biodiversity, propagation, conservation and utilization.

Practical schedule

1. Field exploration trips- exercise in collection and characterization
2. Visit to field germplasm unit and documentation of germplasm
3. Practices in maintenance of passport data
4. Practical study of *ex situ* conservation methods
5. Practical study of *in situ* conservation methods
6. Methods of seed storage for short and long term conservation
7. Methods of conservation using vegetative propagules
8. *In vitro* conservation protocols
9. Study of species diversity in horticultural cropping system
10. Visit to regional conservation centres
11. Visit to subtropical and temperate zone medicinal & aromatic crop fields
12. Characterization of coffee germplasm
13. Characterization of cardamom germplasm
14. Characterization of *Ocimum*. germplasm
15. Identification of minor plantation and spices crops and their description.
16. Use of molecular tools for characterizing species diversity
17. Estimating extent of diversity through collection and analysis of data

Course Outcomes

CO1:The students will be able to identify the genetic resources of underutilized medicinal and aromatic plants

CO2:They will be able to demonstrate conservation techniques followed for underutilized medicinal and aromatic plants.

CO3:They will be able to identify underutilized minor medicinal crops.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference books

1. Frankel, O.H. and J.G. Hawkes. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.UK.
2. Peter, K.V. and Z .Abraham (Eds) .2007. Biodiversity in Horticultural Crops.Vol.1 Daya Publishers, New Delhi.
3. Peter, K.V. (Ed).2008. Biodiversity in Horticultural Crops.Vol.2 Daya Publishers, New Delhi.
4. Peter, K.V. (Ed).2010. Biodiversity in Horticultural Crops.Vol.3 Daya Publishers, New Delhi.

OPC AEC 621 NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS (2+1)

Objective

To introduce economic principles related to natural resource and environmental economics, explore the concept of efficiency and the efficient allocation of natural resources, understand the economics of environmental problems, explore the concept of pollution control and pollution prevention decisions and understand the environmental policy issues and alternative instruments of environmental policies.

Theory

Unit-I - Basic concepts

Concepts, classification, problems of natural resource economics. Economy - environment interaction - the material balance principle, entropy law. Resource scarcity - limits to growth - measuring and mitigating natural resource scarcity - Malthusian and Ricardian scarcity - scarcity indices - resource scarcity and technical change.

Unit-II - Optimal use

Theory of optimal extraction of renewable resources - economic models of forestry, fisheries - logistic growth curve - maximum sustainable yield and economic yield - theory of optimal depletion of exhaustible resources - efficiency - time path of prices and extraction. Economic models of oil extraction - Hotelling's rule - Solow Harwick's rule.

economic perspective - indicators of sustainability - relationship between development and environmental stress, poverty and environment - Environment Kuznet's Curve (EKC) - environmental accounting - resource accounting methods. International environmental issues - climate change - likely impacts - adaptation and mitigation efforts - international treaties.

Practical

Land use planning - energy use pattern - solid waste management - biodiversity, biopiracy, biosafety issues. Renewable resource management - optimum harvest of forestry/fishery. Exercise on pollution abatement-I. Exercise on pollution abatement-II. Concepts in valuing the environment. Taxonomy of valuation techniques - productivity change method - substitute cost method - hedonic pricing method - travel cost method - contingent valuation method. Discount rate in natural resource management. Environment impact assessment. Visit to Pollution Control Board. Social cost benefit analysis.

Theory schedule

1. Concepts, classification, problems of natural resource economics
2. Economy - environment interaction
3. The material balance principle, entropy law
4. Resources scarcity - limits to growth

5. Measuring and mitigating natural resource scarcity
6. Malthusian and Ricardian scarcity - scarcity indices
7. Resource scarcity and technical change
8. Theory of optimal extraction renewable resources
9. Economic models of forestry
10. Economic models of fisheries
11. Logistic growth curve - maximum sustainable yield and economic yield
12. Theory of optimal extraction of exhaustible resources
13. Efficiency - time path of prices and extraction
14. Economic models of oil extraction
15. Hotelling's rule, Solow - Harwick's Rule
16. Efficiency and markets - market failures
17. **Mid semester examination**
18. Externalities - types
19. Property rights - transaction costs
20. Coase's theorem and its critique
21. Public goods - common property and open access resource management
22. Collective action - environmental regulation
23. Economic instruments
24. Pollution charges - Pigouvian tax
25. Carbon trading
26. Tradable permits
27. Indirect instruments
28. Environmental legislations in India
29. Concept of sustainable development
30. Economic perspective - indicators of sustainability
31. Relationship between development and environmental stress, poverty and environment, Environment Kuznet's curve
32. Environmental accounting - resource accounting methods
33. International environmental issues - climate change - likely impacts
34. Adaptation and mitigation efforts - international treaties

Practical schedule

1. Land use planning
2. Energy use pattern
3. Solid waste management
4. Biodiversity, biopiracy, biosafety issues - case studies
5. Renewable resource management
6. Optimum harvest of forestry/fishery
7. Discount rate in natural resource management
8. Exercise on pollution abatement - I
9. Exercise on pollution abatement - II
10. Concepts in valuing the environment
11. Taxonomy of valuation techniques
12. Productivity change method - substitute cost method
13. Hedonic pricing method - travel cost method
14. Contingent valuation method - discount rate in natural resource management
15. Environment impact assessment
16. Visit to Pollution Control Board
17. Social cost, benefit analysis

Course Outcomes

1. Gain knowledge on basic concepts of environmental economics.
2. Identify the optimal extraction level of renewable resources using economic models.
3. Assess the ways to manage common property resources.
4. Understand environmental legislations in India.
5. Analyse economic problems related to natural resource use including climate change problems.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference books

1. Conard, J.M. and W. Collin, 1987. *Natural Resource Economics, Notes and Problems*, Cambridge University Press, London.
2. Kerr, J.M., Marothia D.K., Katar Singh, Ramasamy C. and Bentley W.R., 1997. *Natural Resource Economics: Theory and Applications in India*, Oxford and IBH, New Delhi.
3. Pearce, D.W. and Turner K., 1990. *Economics of Natural Resources and the Environment*, John Hopkins Univ. Press., London.
4. Sengupta, R., 2000. *Ecology and Economy, an Indian Perspective*, Oxford Univ. Press, New Delhi.
5. Tietenberg, T., 2003. *Environmental and Natural Resource Economics*, 6th Ed., Addition Wesley.
1. <http://www.iisd.org/publications>
2. <http://www.valuing-nature.net/>
3. www.teebweb.org
4. <http://ocw.mit.edu/courses/environment-courses/>
5. <http://www.colorado.edu/Economics/morey/4545/4545lnts.html>
6. <http://pubs.iied.org/>
7. <http://www.unep.org/publications/>
8. <http://www.env-econ.net/>
9. <http://environment.yale.edu/TEEB>

OPC AEC 711 AGRI BUSINESS ANALYSIS (2+1)

Objective

The objective of this course is to teach the students the basic concepts, principles and tools of agri/farm business management.

Theory

Unit-I - Agribusiness - basic concepts

Definition - basic concepts - structure of agribusiness - agribusiness sectors - special features of agribusiness - importance of agribusiness in Indian economy - role of farm business management - farm management decisions - farm management problems.

Unit-II - Principles of management

Management - definitions and importance - management functions - nature, roles, skills, levels and functional areas of management. Forms of business organization - sole proprietorship - partnership - private and public limited - cooperatives.

Unit-III - Elements of management

Planning - definition - types of plans - steps in planning - advantages of planning. Organizing - structure, departmentation - line and staff functions - centralization and decentralization - formal and informal organizations. Staffing - human resource planning - process. Directing - concept, principles, techniques, supervision - motivation - communication - leadership. Controlling - concept, steps, types, process.

Unit-IV - Approaches in agribusiness management

Approaches to management - Management By Objectives (MBO) - Quality Circle (QC) - profit center approach - Strength, Weakness, Opportunity and Threat (SWOT) - Management Information System (MIS) - agribusiness management - future prospects.

Unit-V - Tools of farm management

Principle of variable proportion - cost principle - factor substitution, opportunity cost principle. Farm business analysis - valuation of farm assets and depreciation - net worth statement - income statement - cash flow statement. Farm planning and budgeting - complete budget, partial budget, enterprise budget. Farm records and accounts - types of farm record. Management of farm resources - land, labour, farm machinery, farm building etc., - break even analysis.

Practical

Agribusiness opportunities - business project preparation - business project scheduling - inventory management - production management - working capital management - repayment schedule of loans - feasibility control network analysis - project evaluation - visit to agro processing units and agribusiness units - consumer survey - market potential assessment. Farm survey - methods of data collection - estimation of cost of cultivation for annual and perennial crops - estimation of cost of production of milk, egg, broiler, fish - valuation of farm assets - depreciation of farm assets - farm financial statements - balance sheet - income statement - cash flow statement - budgeting - complete budgeting and partial budgeting - break even analysis.

Theory schedule

1. Definition - basic concepts - structure of agribusiness
2. Agribusiness sectors - special features of agribusiness
3. Importance of agribusiness in Indian economy
4. Role of farm business management
5. Farm management decision
6. Farm management problems
7. Management - definitions and importance
8. Management functions - nature, roles, skills, levels
9. Functional areas of management
10. Forms of business organization
11. Sole proprietorship, partnership
12. Private and public limited, cooperatives
13. Planning - definition - types of plans
14. Steps in planning - advantages of planning
15. Organizing - structure, departmentation - line and staff functions
16. Centralization and decentralization
17. **Mid semester examination**
18. Formal and informal organizations
19. Staffing - human resource planning process
20. Directing - concept, principles, techniques, supervision
21. Motivation - communication - leadership
22. Controlling - concept, steps, types, process
23. Approaches to management - Management By Objectives (MBO)
24. Quality Circle (QC) - profit center approach

25. Strength, Weakness, Opportunity and Threat (SWOT)
26. Management Information System (MIS) - agribusiness management - future prospects
27. Principle and variable proportion - cost principle
28. Factor substitution, opportunity cost principle
29. Farm business analysis - valuation of farm assets and depreciation
30. Net worth statement - income statement - cash flow statement
31. Farm planning and budgeting - complete budget, partial budget, enterprise budget
32. Farm records and accounts - types of farm records
33. Management of farm resources, land, labour, farm machinery, farm building
34. Break even analysis

Practical schedule

1. Agribusiness opportunities
2. Business project preparation
3. Business project scheduling
4. Inventory management
5. Production management
6. Working capital management
7. Repayment schedule of loans
8. Feasibility control network analysis - project evaluation
9. Visit to agro processing units and agribusiness units
10. Consumer survey - market potential assessment
11. Farm survey - methods of data collection
12. Estimation of cost of cultivation for annual and perennial crops
13. Estimation of cost of production of milk, egg, broiler, fish
14. Valuation of farm assets - depreciation of farm assets - budgeting
15. Farm financial statements - balance sheet - income statement - cash flow statement
16. Complete budgeting and partial budgeting
17. Break even analysis

Course Outcomes

1. Understand special features of agribusiness and its importance in Indian economy.
2. Understand the principles of agribusiness management.
3. Know the ways to communicate information effectively and economically.
4. Analyse the future prospects of agribusiness using different approaches of management.
5. Estimate economic and financial feasibility of agri-business industries.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference books

1. Acharya, S.S. and N.L. Agarwal, 2004. *Agricultural Prices - Analysis and Policy*, Oxford and IBH, New Delhi.
2. Acharya, S.S., and N.L. Agarwal, 2008. *Agricultural Marketing in India*, Oxford and IBH, New Delhi.

3. Francis Cherunilam, 2006. *International Trade and Export management*, Himalaya Publishing House, Mumbai.
4. Singh, S.K., 2006. *Agricultural Management (Vol. I)*, Mittal Publications, New Delhi.
5. Stephen P Robbins, 2007. *Organizational Behaviour*, Prentice Hall, New Delhi.

1. <http://ocw.mit.edu/courses/economics>
2. <https://www.msu.edu/course/ECO/855>
3. <http://www.uky.edu/~deberti/prod/agprod5.pdf>
4. http://www.csuchico.edu/ag/_assets/documents/syllabi/ABUS/ABUS%20301%20AG%20Production%20Econ%20Analysis.pdf

OPCAEC 712 AGRICULTURAL INSURANCE AND RISK MANAGEMENT (2+1)

Objective

The aim of this course is to provide the students a thorough knowledge on the principles of insurance, practices of risk management and various insurance policies and schemes available for agri business.

Unit-I - Agricultural finance

Role and importance of agricultural finance. Financial institutions and credit flow to rural/priority sector. Agricultural lending - direct and indirect financing - financing through co-operatives, NABARD, Commercial Banks and RRBs. District Credit Plan- and lending to agriculture/priority sector. The concept of 5 C's, 7 P's and 3 R's of credit.

Unit-II - Classification of risks

The concept of risk - kinds and classification of risks - assessment - the concept of insurance - types of general insurance - agriculture, fire, marine, engineering - insurance of property. Insurance professionals and intermediaries.

Unit-III - Principles of insurance

Basic principle of insurance - utmost good faith - insurable interest - material facts - economic principles - sharing - subrogation - contribution - legal principles - the Indian Contract, 1872 - insurable interest - nomination and assignment - financial principles - premium funds - investments.

Unit-IV - Agricultural risks

Agricultural risks - sources of risk - production and technical risk, output and input price risk, financial risk, political risk, legal risk, personal risk. Risk management tools. Low risk investments. Enterprise diversification - excess - debt capacity, liquid financial reserves. Off - farm Income, shared ownership or leasing risk transfer insurance products. Contracts - hedging and options market.

Unit-V - Agricultural insurance

Agricultural insurance - importance of agricultural insurance - scope - genesis - crop insurance development in India - Comprehensive Crop Insurance Scheme (CCIS) - advantages - livestock insurance - agencies of agricultural insurance - General Insurance Corporation - New India Assurance - Agricultural Insurance Corporation - National Agricultural Insurance Scheme - business loss estimation - appraisal - claiming and repayment. Types of insurance products - stakeholders.

Practical

Estimation of cost of cultivation for major crops. Procedure on scale of finance for major crops. Estimation of technical feasibility, economic viability of farmers - Repaying capacity of borrowers and appraisal of credit proposals. Analysis of trend in farm lending and over dues - assessment of farm credit needs. Collection of farm level data on yield and crop losses. Visit to commercial bank, insurance agency - processes and procedure for agricultural insurance - crop loss assessment - estimation of indemnity - actuarial method of

premium calculation - pure risk rate liability - case study on insurance development - case study on problem and prospect of insurance in India - role of government in farm insurance.

Theory schedule

1. Agricultural finance
2. Role and importance of agricultural finance
3. Financial institutions and credit flow to rural/priority sector
4. Agricultural lending - direct and indirect financing
5. Financing through co-operatives
6. Role of NABARD, Commercial Banks and RRBs
7. District credit plan and lending to agriculture/priority sector
8. The concept of 5 C's, 7 P's and 3 R's of credit
9. The concept of risk - kinds and classification of risks - assessment
10. The concept of insurance - types of general insurance - agriculture, fire, marine, engineering
11. Insurance of property - insurance professionals and intermediaries
12. Basic principle of insurance - utmost good faith - insurable interest - material facts
13. Economic principles - sharing - subrogation - contribution
14. Legal principles - the Indian contract, 1872
15. Insurable interest - nomination and assignment
16. Financial principles - premium funds - investments
17. **Mid semester examination**
18. Agricultural risks - sources of risk - production and technical risk
19. Output and input price risk
20. Financial risk - political risk - legal risk - personal risk
21. Risk management tools
22. Low risk investments - enterprise diversification
23. Excess - debt capacity - liquid financial reserves off - farm income - shared ownership or leasing
24. Risk transfer insurance products - contracts - hedging and options market
25. Agricultural insurance importance of agricultural insurance - scope
26. Genesis - crop insurance development in India
27. Comprehensive Crop Insurance Scheme (CCIS) - advantages
28. Livestock insurance - agencies of agricultural insurance
29. General Insurance Corporation. New India Assurance
30. Agricultural insurance corporation
31. National agricultural insurance scheme
32. Business loss estimation - appraisal
33. Claiming and repayment
34. Types of insurance products - stakeholders

Practical schedule

1. Estimation of cost of cultivation for major crops
2. Procedure on scale of finance for major crops
3. Estimation of technical feasibility, economic viability of farmers
4. Repaying capacity of borrowers and appraisal of credit proposals
5. Analysis of trend in farm lending and over dues
6. Assessment of farm credit needs
7. Collection of farm level data on yield and crop losses
8. Visit to commercial bank
9. Visit to insurance agency
10. Processes and procedure for agricultural insurance
11. Crop loss assessment

12. Estimation of indemnity
13. Actuarial method of premium calculation
14. Pure risk rate liability
15. Case study on insurance development
16. Case study on problem and prospect of insurance in India
17. Role of government in farm insurance

Course Outcomes

1. Understand the role of financial institutions in agricultural development.
2. Understand kinds of risk in agriculture and allied sectors.
3. Know the principles of insurance and assess the credit need.
4. Analyse different risk management techniques.
5. Discuss the role of agencies involved in agricultural insurance and types of insurance products.

CO-PO Mapping with POs of Agricultural Entomology

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

Reference books

1. *Crop Insurance*, 1998. Publication of Insurance Institution of India, Mumbai.
2. David, C. and Debertin, 1986. *Agricultural Production Economics*, Mac Millan Publishing Company, New York.
3. *General Insurance*, 2004. Publication of United India Insurance Co, Ltd., Chennai.
4. Watis and Associate, IIRM, 2014. *Introduction to Agricultural Insurance and Risk Management*, World Bank Corporation, International Finance Corporation, Washington.
5. Sankhayan, P.L., 1988. *Introduction to the Economics of Agricultural Production*, Prentice Hall of India, New Delhi.
1. <http://pages.stern.nyu.edu/~adamodar/>
2. <http://educ.jmu.edu/~drakepp/>
3. www.microfinancegateway.org
4. <http://www.ruralfinance.org>
5. www.nabard.org
6. www.rbi.org

OPCAEX 711 FARM JOURNALISM (2+1)

LEARNING OBJECTIVES

To enable the students to learn about

- Agricultural Journalism and its role in agricultural development
- Skills in script writing for different media.
- Online journalism and Web writing
- Preparation of short films

THEORY

Unit I - PRINT MEDIA

Journalism, Concept, Types, Principles, Scope, Importance, elements, qualities of News. Script writing for print media - News stories, news, success stories, features. Nature and characteristics of Newspaper - Readers' perception - Photo journalism - importance and functions.

Unit II- MAGAZINES

General magazines – basics of writing farm articles – contents – target readers – language – writing style – pictures and illustrations – features and special articles – Tamil Agricultural Magazines.

Unit III – RADIO

Nature and characteristics of Radio – Radio for information, education and entertainment – News headlines and highlights – News features – talk shows, interviews – Radio audiences – audience participation – language and style – target audience – script writing for radio.

Unit IV – TELEVISION

Nature and characteristics of television – audio and visual elements – script writing television – time factor – information and educational programmes – general and special audience programmes – language and style of presentation – entertainment programmes – audience participation.

Unit V – WEB WRITING

Understanding and using the Internet – Online journalism – Agricultural News – Agricultural technology – Newspapers online – e-journals and e-magazine – textual – language and style – multimedia support – contents online: informational and educating market information. Content developing using links and text.

PRACTICAL

Writing for the print media preparing and editing news items for Newspapers. Practicing photography and videography, Visit to a newspaper organization. Preparation of leaflets and folders. Designing a cover for farm magazine. Preparing the radio script, practicing the radio script, Visit to FM radio station. Practicing the script writing for television. Designing visuals, graphics and Illustrations for television. Designing a programme on Interview with farmer. Preparation of short film, Visit to local TV channel, Visit to Doordharsan Kendra. Preparation of Interview Schedule to study the preference of farmers towards mass media.

LECTURE SCHEDULE

- 1) Journalism, Concept, Types
- 2) Principles, Scope, Importance
- 3) Elements / qualities of News
- 4) Script writing for print media
- 5) Script writing for news, success stories, features
- 6) Nature and characteristics of Newspaper – Readers' perception
- 7) Photo journalism – scope and importance
- 8) Photo journalism – functions
- 9) General magazines – basics of writing farm articles
- 10) General magazines - Contents – target readers – language.
- 11) Writing style – pictures and illustrations – features and special articles
- 12) Tamil Agricultural Magazines– pictures and illustrations - Writing style.
- 13) Nature and characteristics of Radio
- 14) Radio for information, education and entertainment.
- 15) News headlines and highlights – News features
- 16) Talk shows, interviews.
- 17) Mid Semester Examination**
- 18) Radio audiences – audience participation – language and style
- 19) Target audience – script writing for radio
- 20) Nature and characteristics of television
- 21) Audio and visual elements
- 22) Script writing for television
- 23) Time factor – information and educational programmes

- 24) General and special audience programmes
- 25) Language and style of presentation
- 26) Entertainment programmes – audience participation
- 27) Understanding and using the Internet
- 28) Online journalism
- 29) Agricultural News – Agricultural technology – Newspapers online
- 30) e-journals – textual – language and style
- 31) e-magazine – textual – language and style
- 32) Multimedia support – contents online
- 33) Informational and educating market information
- 34) Content developing using links and text.

PRACTICAL SCHEDULE

- 1) Writing for the print media
- 2) Preparing and Editing news items for Newspapers.
- 3) Practicing photography.
- 4) Practicing videography
- 5) Visit to a newspaper organization.
- 6) Preparation of leaflets and folders.
- 7) Designing a cover for farm magazine.
- 8) Preparing the radio script
- 9) Practicing the radio script
- 10) Visit to FM radio station.
- 11) Practicing the script writing for television.
- 12) Designing visuals, graphics and Illustrations for television.
- 13) Designing a programme on Interview with farmer.
- 14) Preparation of short film
- 15) Visit to local TV channel
- 16) Visit to Doordharsan Kendra.
- 17) Preparation of Interview Schedule to study the farmer preference towards mass media.

COURSE OUTCOMES

CO 1: Develop skills about the art of script writing for different media.

CO 2: Practice and prepare for online journalism and web writing

CO 3: Develop skills to prepare and shoot the video programme.

CO 4: Prepare short films

CO 5: Practice and develop skill on efficient handling of digital camera.

CO-PO Mapping with POs of Agricultural Entomology

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

REFERENCES

- 1) G.L. Ray and SagarMondal. 2010. Journalism, Farm Journalism and communication skills.
- 2) Jana.B.L. &Mitra K.P.2005. Farm Journalism. Agro. Tech Pull. Academy.
- 3) C. Bhaskaran&Kishore Kumar 2010. Farm journalism and media management, Agri. Teck, Udaipur.

- 4) Shrivastava, K.M. 'Radio and TV Journalism Today'. New Delhi, Sterling Publication. 1989.
- 5) Hilliart, Robert. 'Writing for television, radio and New media (8th Edison). Belmont. Wadsworth publication 2004.

E- Resources

1. www.farmjournal.com
2. www.agriculturetoday.in
3. <https://screecraft.org/education>
4. www.slideshow.net/handbookoffarmjournalism
5. www.mediacolleg.com

OPCAEX 712 INTRODUCTION TO VISUAL COMMUNICATION AND ADVERTISING TECHNOLOGIES (2+1)

LEARNING OBJECTIVES

To enable the students to learn about

- Principles and concepts of visual communication
- Scope, concept and trends of advertising
- Various formats of advertising
- Elements of graphic design

THEORY

UNIT I - VISUAL COMMUNICATION

Need for and the Importance of Visual Communication. Communication as an expression, skill and process, Understanding Communication - Message, Meaning, Connotation, Denotation, Codes - Levels of communication: Technical, Semantic, and Pragmatic. The semiotic landscape: language and visual communication, narrative representation

UNIT II - COLOUR PSYCHOLOGY AND TYPES OF MEDIA

Principles of Visual and other Sensory Perceptions. Colour psychology and theory - Optical / Visual Illusions - Types of Media - Print media, Electronic media and recent media in communication

UNIT: III -GRAPHIC DESIGN

Basic of Graphic Design, Definition, Elements of Graphic Design. The process of developing ideas - Verbal, Visual, Combination and thematic, visual thinking, design execution and presentation.

UNIT IV - IV ADVERTISING

Definition, Nature & Scope of advertising, Roles of Advertising; Societal, Communication, Marketing & Economic functions of advertising. Advertising based on target audience, geographic area, Corporate and Promotional Advertising. Web Advertising.

UNIT V -TRENDS AND TYPES OF ADVERTISING

Latest trends in advertising- Advertisement agency & its types, functions, services- Legal aspects & ethical issues. Communication Plan, Brand management - Positioning, Brand personality, Brand image, Brand equity. Conceptualization & Ideation, Visualization, Designing & Layout, Copy writing - Types of headlines, body copy base lines, slogans. Logos & trademarks. Typography, writing styles, Scripting. Story board. Advertising campaign-from conception to execution

PRACTICAL

Geometrical Shapes - Perspectives - Light and shade - Story Board Colours - Visit to an advanced digital studio - Design ear panels - Design a visual dominant advertisement - Design a souls advertisement - Design an advertisement for a consumer product - Design a corporate advertisement - Design a public service advertisement - Design a testimonial advertisement - Design a comparative advertisement - Design an advertisement for brand

promotion - Design an advertisement with emotional appeal- . Design an advertisement with fear appeal - Design an advertisement with humor appeal

LECTURE SCHEDULE

- 1) Need for and the Importance of Visual Communication.
- 2) Communication as an expression, skill and process, Understanding Communication
- 3) Message, Meaning, Connotation, Denotation, Codes
- 4) Levels of communication, Technical, Semantic and Pragmatic
- 5) The semiotic landscape: language and visual communication, narrative representation
- 6) Principles of Visual and other Sensory Perceptions.
- 7) Colour psychology and theory
- 8) Optical / Visual Illusions
- 9) Types of Media
- 10) Print media, Electronic media
- 11) Recent media in communication
- 12) Basics of Graphic Design. Definition, Elements of Graphic Design
- 13) Design process-research, a source of concept, the process of developing ideas
- 14) Verbal, visual, combination and thematic
- 15) Visual thinking, associative techniques, materials, tools
- 16) Design execution, and presentation.
- 17) **Mid semester Examination**
- 18) Definition, Nature & Scope of advertising
- 19) Roles of Advertising
- 20) Societal, Communication, Marketing & Economic functions of advertising
- 21) Advertising based on target audience, geographic area
- 22) Corporate and Promotional Advertising
- 23) Web Advertising
- 24) Latest trends in advertising
- 25) Advertisement agency & its types, functions, services
- 26) Legal aspects & ethical issues in advertising
- 27) Communication Plan and Brand management
- 28) Positioning, Brand personality, Brand image, Brand equity
- 29) Conceptualization, Ideation, Visualization designing and layout
- 30) Copy writing - types of headlines
- 31) Slogans- types of slogans
- 32) Logos and Trademarks
- 33) Typography and Writing styles, Scripting and Story board
- 34) Advertising campaign-from conception to execution

PRACTICAL SCHEDULE

- 1) Practicing Geometrical Shapes in visual designs
- 2) Practicing Perspectives in visual designs
- 3) Practicing Light and shade in visual designs
- 4) Practicing Story Board Colours in visual designs
- 5) Visit to an advanced digital studio
- 6) Design ear panels
- 7) Design a visual dominant advertisement
- 8) Design a souls advertisement
- 9) Design an advertisement for a consumer product

- 10) Design a corporate advertisement
- 11) Design a public service advertisement
- 12) Design a testimonial advertisement
- 13) Design a comparative advertisement
- 14) Design an advertisement for brand promotion
- 15) Design an advertisement with emotional appeal
- 16) Design an advertisement with fear appeal
- 17) Design an advertisement with humorous appeal

COURSE OUTCOMES

CO 1 :Understand Principles and concepts of visual communication.

CO 2 :Design various formats of advertising.

CO 3 :Design web advertising.

CO 4 :Design various visual designs and develop story board colours.

CO 5: Develop skill on designing farm advertisements.

CO-PO Mapping with POs of Agricultural Entomology

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

REFERENCES

- 1) *Visual Communications*, Hasan Siddiqui, Anmol Publications Pvt Ltd, 2011
- 2) *Visual Communications*, Paul Martin, Bio Green Books, 2016
- 3) *Practice of Advertising*, Adrian R Mackay, Reed Elsevier India Pvt.Ltd, 2005
- 4) *Handbook of Advertising*, Christopher Jones, Nabu Press, 2010
- 5) *Advertising Handbook*, Alistair Paterson, Routledge, 2002

E- Resources

1. www.iadtdesign.com
2. www.pinterest.com
3. www.vcgcorporate.com
4. www.blog.bannersnack.com
5. www.wordstream.com

SUPPORTING COURSES

STA 611 STATISTICAL METHODS AND DESIGN OF EXPERMENTS (2+1)

Learning objectives

- To emphasize the students to learn the principles and methods of statistics to carry out analysis of data obtained through experiments.

THEORY

Unit I Concepts in statistics

Population and sample, parameter and statistic -concept of sampling - simple random sampling - concept of probability distribution - binominal, poisson and normal distributions - F and Chi square distribution- estimation -point estimation- interval estimation- degrees of freedom- concept of sampling distribution - standard error- tests of significance based on t, z, (mean and equality of means only)- χ^2 test for goodness of fit.

Unit II Correlation and Regression

Definition, types and methods of studying correlation - properties of correlation coefficient- regression - measuring and uses of regression analysis - properties- differences between

correlation and regression. regression co-efficient - simple-linear - multiple linear regression co-efficient - standard error of estimate - test of significance of observed regression co-efficient and co-efficient of determination - non linear regression- misuses of correlation and regression in agricultural research.

Unit III Basic designs

Agricultural experiments: concepts - field studies - pot-culture - quantitative and qualitative variables- errors: sources of errors and estimate of errors- basic principles of design of experiments - CRD - RBD - LSD layout and their analysis - efficiency.

Unit IV Mean comparison and missing data

Comparison of treatments - least significant difference method - Duncan's multiple range test (DMRT)- missing plot technique in RBD and LSD (one and two missing)- concept of analysis of covariance- data transformation: logarithmic square root and arc sine.

Unit V Factorial experiments

Concept of factorial experiments - 2^n , 3^2 factorial experiments- principle of confounding in factorial experiments - confounding in 2^3 factorial experiments- split-pot design and strip - plot design.

PRACTICAL

Estimation of samples statistic *viz.*, means, sd, se and cv. z-test, t-test and paired t-test-comparison of two variances using F-test-bartlett's test for homogeneity of variances- Chi-square test for test of goodness of fit and homogeneity of ratio test for independence of attributes.computation of correlation co-efficient and its significance- fitting of simple linear regression and testing the significance of regression co-efficient- multiple linear regressions fitting and testing -determination of optimum plot size using uniformity trial-analysis of CRD, RBD, LSD and DMRT- analysis of multi-observation data (sampling in rbd) -missing plot technique in RBD with one or two missing values -analysis of factorial experiments conducted in RBD- analysis of split-plot and strip-plot design- analysis of data with transformations.

LECTURE SCHEDULE

1. Definition of population and sample
2. Difference between parameter and statistic
3. Concept of sampling - simple random sampling
4. Concept of probability distribution - Binominal, Poisson and Normal distributions.
5. F and Chi square distribution
6. Estimation - point estimation, interval estimation, degrees of freedom.
7. Concept of sampling distribution - Standard Error.
8. Tests of significance based on t, z, (mean and equality of means only). χ^2 test for goodness of fit.
9. Definition of correlation, significance and types
10. Properties of correlation coefficient
11. Definition of regression - measuring and uses of regression analysis properties.
12. Differences between correlation and regression.
13. Regression co-efficient - simple, linear.
14. Multiple linear regression co-efficient - standard error of estimate.
15. Test of significance of observed regression co-efficient and co-efficient of determination.
16. Non linear regression-misuses of correlation and regression in agricultural research.
17. **Mid- semester examination**
18. Characteristics of agricultural experiments: concepts - field studies.
19. Characteristics of agricultural experiments -pot-culture - quantitative and qualitative variables.
20. Sources of errors and estimate of errors

21. Design of Experiments- Basic principles of CRD
22. Design of Experiments- Basic principles of RBD
23. Design of Experiments- Basic principles of LSD
24. Efficiency of designs -layout and their analysis
25. Comparison of treatments – least significant difference method
26. Duncan’s Multiple Range Test (DMRT).
27. Missing plot technique in RBD and LSD (one and two missing).
28. Concept of analysis of covariance
29. Data transformation: logarithmic square root and arc sine.
30. Concept of factorial experiments
31. 2^n , 3^2 Factorial experiments,
32. Principle of confounding in factorial experiments
33. Confounding in 2^3 Factorial experiments.
34. Split-plot design and strip – plot design.

PRACTICAL SCHEDULE

1. Estimation of samples statistic *viz.*, means, SD, SE and CV.
2. Z-test, t-test and paired t-test.
3. Comparison of two variances using F-test
4. Bartlett’s test for homogeneity of variances.
5. Chi-square test for test of goodness of fit and homogeneity of ratio test for independence of attributes.
6. Computation of correlation co-efficient and it’s significance.
7. Fitting of simple linear regression and testing the significance of regression co-efficient.
8. Multiple linear regressions fitting and testing
9. Determination of optimum plot size using uniformity trial.
10. Analysis of CRD.
11. Analysis of RBD
12. Computation of LSD and DMRT
13. Analysis of multi-observation data (sampling in RBD)
14. Missing plot technique in RBD with one or two missing values.
15. Analysis of Factorial experiments conducted in RBD
16. Analysis of Split-plot and Split-plot design.
17. Analysis of data with transformations.

Course Outcomes

CO1: The students can understand the basic statistical concepts applied in agricultural research

CO2: Can apply statistical tools in design of experiments

CO3: Can acquire skills in analyzing statistical data efficiently

CO -PO mapping

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

Reference books

1. Bhattacharyya, G.K. and R.A. Johnson. 1997. Statistical concepts and methods, John Wiley and Sons, New York.
2. Crozon, F.E. and D.J. Cowden . 1986. Applied General Statistics, Prentice Hall of India, New Delhi.
3. Gomez, K.A. and A.A. Gomez. 1984. Statistical procedure for Agricultural Research, John Wiley and Sons, New York.

4. Panse, V.G. and P.V. Sukhatme. 1961. Statistical methods for Agricultural Workers, ICAR, New Delhi.
5. Ramaswamy, R. 1995. A text book of Agricultural Statistics, Wiley Limited, New Delhi.

COM 611 - COMPUTER APPLICATIONS FOR AGRICULTURAL RESEARCH (1 + 1)

Learning Objectives

- 1.To understand the basics of Computer and to gain abundant knowledge in information technology.
- 2.To know how to use office automation tools to increase personal and academic productivity.
- 3.To get exposed to aspects of internet usage and to propagate the awareness of research facilities using browsing and searching.

Theory

Unit - I Introduction to Computer

Overview of Computers - Devices of a Computer and their functions - Classification of Computers - Hardware - Software - Classification of Software - Operating System - Dos - Windows - Unix - VIRUS - Current trends in Hardware and Software.

Unit -II Word Processor & Spread Sheet Applications

MS-Word - Word Processing and Components of Word Ribbon - Creating, Editing and Printing of a document - Features of word like Page setting, Font, Paragraph, Table, Clip arts, Text box, Spell check, Grammar check - Mail Merge concepts. MS-Excel - Ribbon Components - Spread sheet - Creating a simple formula and Aggregate function - Preparation of charts - Applying Conditional formula - Use of Data Analysis tools.

Unit - III Database & Presentation

MS-Access - Creation of database, storing and retrieval - Table form - Adding records - SQL Query - using GUI to design printing layout - Report generation. MS-PowerPoint - Slide preparation - Components of PowerPoint Ribbon - Adding slides with different layouts - Design, Custom Animation and Transition effects.

Unit - IV Internet, Webpage Design & Networks

Introduction to Internet - Service providers - Web browser - Search engines - Internet applications - Cyber Security - Types of Web Pages - HTML webpage design - Usage of script language - Introduction to Computer Networks- Topologies - Network device - Current trends in Networks & Internet.

Unit - V Agricultural Statistical Software

SAS, MSTAT, IRRISTAT, AGRES, AGRISTAT, STATISTICA, MANOVA, MANCOVA AND SPSS.

Theory Schedule

- 1.Introduction to Computers, Anatomy of Computers.
- 2.Input and Output devices, Units of memory, Hardware, Software and Classification of Computers.
- 3.Software, Categories of software, Operating System, Types of operating system.
- 4.Bootting sequence of operating system, DOS, Windows, Unix, VIRUS.
- 5.Word Processer and their components of ribbon.
- 6.Creating, Editing and printing a document, Features of word Table creation,Insert menu option.
- 7.Creation of spread sheet and their ribbon components.
- 8.Creating different types of graphs and working procedure of Aggregate function and data analysis.
- 9.Concepts of Database, Creating Database.

10.Mid semester Examination

11. Creation, Storing and retrieval of data from database and report generation.
12. PowerPoint preparation, Different layouts, Design Custom Animation and Transition effects.
13. Introduction to Internet and its applications
14. Types of WebPages, Service providers, Web browser and Search engines
15. HTML and usage of script language.
16. Introduction to Networks Concepts.
17. SAS, MSTAT, IRRISTAT and AGRISTAT.
18. MANOVA, MANCOVA and SPSS.

Practical schedule

1. Introduction to Hardware, Software and Operating System.
2. Study of Dos and Unix Commands.
3. MS-Word - Create, Edit and Print a document and Ribbon features.
4. MS-Word - Formatting, Inserting, Table creation and Alignment.
5. MS-Word - Creating a Mail Merge.
6. MS-Excel - Inbuilt Functions, Chart preparations.
7. MS-Excel - Prepare Student mark sheet with Aggregate and draw chart.
8. MS-Excel - Prepare Employee payroll with Income tax and draw chart.
9. MS-Excel - Statistical Function and Data analysis tools.
10. MS-Access - Database Creation.
11. MS-Access - Insert, Update and Delete data from the database.
12. MS-Access - Query Execution and Report generation.
13. Webpage creation using basic HTML tags.
14. Webpage creation with Hyperlink and Images.
15. Email - Compose, Attaching, Browsing a webpage .
16. IRRISTAT, AGRESS
17. SPSS - Median, Mode Standard Deviation and Correlation.
18. SPSS - Regression for Linear and Non linear.
19. Model Practical Examination.

Course Outcomes

1. Understand the difference between an operating system and application program, and what each is used for in a computer
2. Performing common basic functions like editing, formatting, printing, scanning etc using tools.
3. Ability to sort data, manipulate data using formulas and Statistical function and Data analysis tools .
4. Understanding methods and tools to design, implement in web pages and develop Web Application.
5. Gain expertise on application of spss

PO-CO MAPPING

	PO 1	PO 2	PO3	PO 4	PO5
CO 1	-	-	-	1	3
CO 2	-	-	-	2	3
CO 3	-	-	-	2	3
CO 4	-	-	-	1	3
CO 5	-	-	-	2	3

Reference

1. Mathew Leon and Alexis Leon, 2008. Introduction to Computers, Vikas Publishing House.

2. Katherine Murray, Suzanne Weixel, and Faithe Wempfen, 2011. Learning Microsoft Office 2010 Advanced Skills, Pearson Education/Prentice Hall.
3. Mathew Leon and Alexis Leon, 2012. Internet for Everyone, Vikas Publishing House.
4. Behrouz A FoRouzen, 2003. Data communication and Networking, Tata McGraw Hill Publishing Company Limited, New Delhi.
5. Thomas Powell, 2010. HTML and CSS: the Complete Reference, Fifth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi.

NON CREDIT COMPULSARY COURSES

PGS 611 – AGRICULTURAL RESEARCH ETHICS AND METHODOLOGY (0 + 1)

Learning Objective

- Students will acquire awareness on conducting research with ethics
- To gain familiarity on need based research
- To develop experience on designing of field experiments for various agronomic situations
- To realize good laboratory techniques and practices
- To comprehend about plagiarism, copy right rules and techniques in writing the dissertation

Practical

Agricultural research system - need, scope, opportunities, role in food security, poverty reduction and environmental protection. Research ethics - research integrity, research safety in laboratories, Lab equipments, welfare of animals used in research, computer ethics, standards and problems in research ethics-Good Laboratory Practices – Plagiarism and Copy right rules.

Research – Fundamental vs. applied research – research prioritization and selection of research problem – Research planning - review of literature – setting of objectives and hypothesis – research design and techniques – data collection – analysis – formulation of tables – interpretation of results and thesis writing – writing of research articles - Type and choice of experiment - Designing research programme for experimentation – Formulation and preparation of research / scheme proposal – Impact factor and citation index – different forms of writing in text - citation and references.

Layout of field experiment - Designing - sampling techniques - Use of experimental tools and equipments for recording observation and analysis – recording biometric observations - data analysis - Computer software - Tabulation and presentation - Guidelines for thesis and technical paper writing – Appraisal of published research articles - Collection of details on research periodicals - Guidelines for oral / poster presentations – Internet in scientific research.

Practical schedule

1. Agricultural research system – needs, scope, opportunities in the role of food security and poverty reduction.
2. Research ethics: research integrity, computer ethics, standards and problems in research ethics, plagiarism and copy right rules.
3. Research safety in laboratories, good laboratory practices and welfare of animals used in research and learning the use of various lab equipments required for agronomical research.
4. Research prioritization and selection of research problem, basic principles and objectives of the problem.
5. Designing and planning of research programme for field experimentation.
6. Selection of experimental sites and laying out field experiments for various experimental designs.

7. Recording growth parameters and its analysis.
8. **Mid-semester examination**
9. Writing review of literature using various sources of information.
10. Practice on writing materials and methods and ethics involved in the use of biological materials in the research.
11. Writing bibliography and references.
12. Practice in the use of various instruments for field research observations.
13. Recording of yield parameters and yield - tabulation, analysis of results and its Interpretation.
14. Model technical paper writing, guidelines for oral / poster presentation.
15. Practice on discussion of results.
16. Evaluation of research articles on National and International journals with impact factor and citation index.
17. Preparation of research projects/schemes proposal.

Course outcomes

CO 1: The course outcome will convey knowledge on research integrity, ethics and copyright rules

CO 2: The course outcome will augment the knowledge of the students in designing field experiments to address practical need of the farming community

CO 3: The course outcome will able to prioritize the research problem in a specific location

CO 4: The course outcome will assist the scholar in publishing quality research paper in indexed journals

CO 5: The course outcome will fortify the students to lead a research team

CO- PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5
CO1	1	1	-	1	1
CO2	2	1	3	1	2
CO3	3	3	3	2	-2
CO4	-	3	-	3	3
CO5	2	3	-	3	3

References

1. Bhalla, GS and Singh, G. 2001. *Indian agriculture - Four decades of development*. Sage Publication.
2. Gomez, K.A. and Gomez, A.A. 1984. *Statistical procedures for agricultural research*. John Willey and Sons, New York
3. Panse, U.G. and Sukhatme, P.V. 1995. *Statistical methods for agricultural workers*. ICAR, New Delhi.
4. Punia, MS. 2016. *Manual on international research and research ethics*. CCS, Haryana Agricultural University, Hisar.
5. Rangaswamy, R. 1995. *A text book of agricultural statistics*. Willey Eastern Limited, New age International Limited Publishers, New Delhi.
6. Sekar, K. 2004. *Research methodology for agricultural sciences*, VelanPathipagam, Chidambaram.

e-Resources

1. www.onlineethics.org
2. <http://ethics.ucsd.edu>
3. <http://naarm.org.in>

PGS 612: TECHNICAL WRITING AND COMMUNICATION SKILLS (0+1)

Learning Objective

- To equip the students with skills Viz., writing of dissertations, research papers, etc. and to communicate and articulate in English

Practical

Grammar - Tenses, parts of speech, clauses, punctuation marks; Error analysis - Common errors; Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers. Proof reading.

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Structure of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Practical schedule

1. Grammar (Tenses, parts of speech)
2. Grammar (clauses, punctuation marks)
3. Error analysis (Common errors); Concord; Collocation;
4. Phonetic symbols and transcription;
5. Accentual pattern: Weak forms in connected speech
6. Participation in group discussion
7. Facing an interview; presentation of scientific papers.
8. Technical Writing- Various forms of scientific writings- theses, technical papers
9. Mid -semester
10. Technical Writing- reviews, manuals
11. Structure of thesis and research communications
12. Writing of abstracts, summaries, précis, citations etc
13. Commonly used abbreviations in the theses and research communications
14. Illustrations, photographs and drawings with suitable captions
15. Pagination, numbering of tables and illustration, numbers and dates in scientific write-ups
16. Editing and proof-reading
17. Writing of a review article.

COURSE OUTCOMES:

At the end of the course, the students will obtain:

CO1-Proficiency in the English language to express their views and ideas without any hindrance

CO2-Competency in communication both written and oral

CO3- Fluency in the English language.

CO4-Word power to use the English language effectively.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	1	3
CO2	-	-	-	2	3
CO3	-	-	-	2	3
CO4	-	-	1	2	3

Suggested Readings

1. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.

2. Mohan K. 2005. Speaking English Effectively. MacMillan India.
3. Richard WS. 1969. Technical Writing. Barnes & Noble.
4. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek.
5. Wren PC & Martin H. 2006. High School English Grammar and Composition. S.Chand & Co.

PGS 623- BASIC CONCEPTS IN LABORATORY TECHNIQUES (0 + 1)

Learning Objectives

- To enlighten the students about the basics of commonly used techniques in laboratory at national and international levels
- To learn the appropriate basics of commonly used techniques and research methodologies adopted to carry out agriculture research problems.
- To learn the knowledge about various concepts and types of research laboratory techniques
- To able to design and follow original laboratory methods and will be able to do concise and persuasive scientific laboratory techniques
- To gain the experience in basic concepts in laboratory techniques and pursue quality research

PRACTICAL

Safety measures while in labs; Handling of chemical substances ; use of burettes ,pipettes, measuring cylinders, flasks, separator funnel, condensers and micropipettes. Washing ,drying and sterilization of glassware; drying of solvents/ chemicals.Weighing and preparation of solutions of different strengths and their dilution ;Handling techniques of solutions; preparations of different agro-chemical doses in field and pot applications; preparation of solutions of acids; Neutralisation of acid and bases ;preparation of buffers of different strengths and ph values.Use and handling of vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens,incubators, sand bath and water bath.Use and handling of microscope and laminar flow-preparation of media- differential ,selective and enriched media. Methods of sterilization –physical methods-dry and moist heat ,cold ,filtration and radiation, chemical methods and disinfectants.

Description of flowering plants in botanical terms in relation to taxonomy- seed viability test-pollen fertility test-tissue culture media-composition of media-media preparation – instant media-aseptic manipulation-procedure for in vitro culture of explants-leaf bit-stem bit-anthers-pollen –microspores-ovule and embryo.

PRACTICAL SCHEDULE

1. Safety measures in labs and handling of chemical substances.
2. Common laboratory equipments.
3. Calibration and cleanliness of volumetric glass wares.
4. Methods of expressing strength of solutions.
5. Preparation of primary standard solutions and buffer solutions.
6. Preparation of standard solutions for nutrient analysis of soil, plant and water.
7. Preparation of different agro-chemical doses for field experiments, Preparation of buffer solutions,
- 8. Mid semester**
9. Handling of instruments-vacuum pumps, thermometers, magnetic stirrer.
10. Handling of instruments-ovens ,sand bath and water bath.
11. Handling and uses of microscopes and laminar flow.
12. Sterilization by physical methods.
13. Sterilization by chemical methods.
14. Preparation of different media for culturing the micro organisms.

15. Description of flowering plants-seed viability test and pollen fertility test.
16. Aseptic manipulations and media.
17. In vitro culture of different explants.

Reference Books

1. Furr ,A.K.2000. CRC Handbook of laboratory safety.CRC press.
2. Jackson, M.L. 1997. Soil Chemical Analysis. Prentice Hall of India pvt.Ltd., New Delhi.
3. Prescott.L.M., Harley, P and Klein, A. 2003. Microbiology, 5thEdition, MC.GrawHill,USA.
4. Gupta,P.K.1997.Elements of Biotechnology,RastogiPublications.Meerut.
5. Singh,B.D. 2005.Bio technology ,Expanding Horizons, Kalyani Publications, New Delhi.

e -courses

1. Analytical chemistry vol.1(pdf) www.freebook centre.net.
2. Analytical chemistry Dr.michaelzehfuswww.free book centre.net.
3. Introduction to Instrumental Analytical Chemistry Roger Terrilwww.freebook centre.net.
4. Analytical Chemistry lecture notes sadhu malyadriwww.freebook centre.net.
5. Short introduction into analytical chemistry Dr.manfredsietz and Dr. Andreassonnenbergwww.freebook centre.net.

Course Outcomes

1. Have core knowledge leading to laboratory techniques and agriculture research system
2. To learn the various concept and terminologies for laboratory techniques.
3. Graduates will be acquiring knowledge about various laboratory techniques of national and international level.
4. Graduates will gains accurate and relevant analytical skill of different analytical skills and will have capacity interrupt information
5. Graduates will be able to develop a analytical skill like methods of soil and plant analysis

PO-CO MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	-	2	1	3
CO2	3	3	-	-	3
CO3	1	-	-	1	2
CO4	3	3	2	2	3
CO5	3	-	-	3	3

PGS 624: LIBRARY AND INFORMATION SERVICES 0+1

Learning Objective

- To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

PRACTICAL

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary -Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services - (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing - information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases,

Online Public Access Catalogue and other computerized - library services; Use of Internet including search engines and its resources; e-resources access methods.

PRACTICAL SCHEDULE

1. Introduction to library and its services
2. Role of libraries in education, research and technology transfer;
3. Classification systems and organization of library
4. Sources of information- Primary -Sources
5. Sources of information -Secondary Sources and Tertiary Sources
6. Intricacies of abstracting and indexing services
7. Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);
8. Tracing - information from reference sources; Literature survey
9. Mid-Semester
10. Citation techniques/Preparation of bibliography;
11. Use of CD-ROM Databases,
12. Online Public Access Catalogue and other computerized - library services
13. Online Public Access Catalogue and other computerized - library services
14. Use of Internet including search engines and its resources
15. Use of Internet including search engines and its resources
16. e-resources access methods.
17. e-resources access methods.

Course outcomes:

1. To equip the library users with skills to trace information from libraries efficiently,
2. To apprise them of information and knowledge resources,
3. To carry out literature survey, to formulate information search strategies, and
4. To use modern tools (Internet, OPAC, search engines etc.) of information search.

PO-CO MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	2	2
CO2	-	1	-	3	2
CO3	1	-	-	2	2
CO4	-	-	1	2	3

PGS 715 Intellectual Property and its Management in Agriculture (1+0) (e-course)

Learning Objectives

- To create awareness about intellectual property rights in agriculture
- To explain management of patents, trademark, geographical indications, copy rights, designs, plant variety protection and biodiversity protection
- To understand marketing and commercialization of intellectual properties

THEORY

Unit - I: World trade organization - introduction

World Trade Organization - Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR) - importance of intellectual property management - IPR and economic growth - IPR and bio diversity - major areas of concern in intellectual property management

- technology transfer and commercialization - forms of different intellectual properties generated by agricultural research.

Unit - II: Patent document

Discovery *versus* invention - patentability of biological inventions - procedure for patent protection - preparatory work - record keeping, writing a patent document, filing the patent document - types of patent application - patent application under the Patent Cooperation Treaty (PCT).

Unit - III: Plant genetic resources

Plant genetic resources - importance and conservation - sui generic system - plant varieties protection and farmers' rights act - registration of extinct varieties - registration and protection of new varieties / hybrids / essentially derived varieties - dispute prevention and settlement - farmers' rights.

Unit - IV: Trademark

Trademark - geographical indications of goods and commodities - copy rights - designs - biodiversity protection.

Unit - V: Benefit sharing

Procedures for commercialization of technology - valuation, costs and pricing of technology - licensing and implementation of intellectual properties - procedures for commercialization - exclusive and non exclusive marketing rights - research exemption and benefit sharing.

THEORY SCHEDULE

1. World Trade Organization - Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR)
2. Importance of intellectual property management - IPR and economic growth - IPR and bio diversity
3. Major areas of concern in Intellectual property management - technology transfer and commercialization
4. Forms of different intellectual properties generated by agricultural research
5. Discovery versus invention patentability of biological inventions
6. Procedure for patent protection
7. Preparatory work - record keeping, writing a patent document, filing the patent document
8. Types of patent application - patent application under the Patent Cooperation Treaty (PCT)
- 9. Mid semester examination**
10. Plant genetic resources - importance and conservation
11. Sui generic system - plant varieties protection and farmers' rights act - registration of extant varieties
12. Registration and protection of new varieties / hybrids / essentially derived varieties - dispute prevention and settlement - farmers' rights
13. Trade mark - geographical indications of goods and commodities - copy rights - designs
14. Biodiversity protection
15. Procedures for commercialization of technology - valuation, costs and pricing of technology
16. Licensing and implementation of intellectual properties - procedures for commercialization

17. Exclusive and non exclusive marketing rights - research exemption and benefit sharing

Course Outcomes

CO1: Understand the concepts in international trade.

CO2: Understand the procedure to obtain patent rights.

CO3: Know the way to protect extinct varieties.

CO4: Create awareness about geographical indications of goods and commodities.

CO5: Identify the way to commercialize intellectual properties.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	-	3
CO2	-	-	-	-	3
CO3	-	-	-	-	3
CO4	-	1	1	1	3
CO5	1	1	1	1	3

References

1. Arun Goyal and Moor Mohamed, 2001. *WTO in the New Millennium*, Academy of Business Studies, New Delhi.
2. BilekDebroy, 2004. *Intellectual Property Rights*, BR World of books, New Delhi.
3. Ganguli, P., 2001. *Intellectual Property Rights - Unleashing the Knowledge Economy*, Tata McGraw Hill, New Delhi.
4. Narayanan, R., 2006. *Patent Law*, Eastern Law House, New Delhi.
5. Ramappa, T., 2000. *Intellectual Property Rights under WTO - Tasks before India*, Wheeler Publishing, New Delhi.

PGS 716 DISASTER MANAGEMENT (1+ 0) (e-Course)

Learning Objectives:

- Students will learn key concepts and types of natural disaster
- Students will acquire knowledge about climate change and its impact
- Students will understand about man made disaster and disaster response mechanisms in India
- Students will equip on disaster warning response and preparedness
- Students will acquire knowledge about climate resilient agriculture

THEORY

Unit I - Natural disaster

Natural Disasters - meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves.

Unit II - Climate change

Climatic change - Global warming, sea level rise, ozone depletion, Manmade disasters - Nuclear disasters, chemical disasters, biological disasters.

Unit III - Man - made disaster

Building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, disaster management- efforts to mitigate natural disasters at national and global levels - India's key hazards, vulnerabilities and disaster response mechanisms in India.

Unit IV - Disaster warning, response and preparedness

Concept of disaster management, national disaster management framework; financial arrangements, role of NGOs, community-based organizations, and media - central, state, district and local administration. Dissemination of disaster warning, response to natural

disasters, national, state, district level, relief – food and nutrition – water – health – mental health services.

Unit V – Rehabilitation

Rehabilitation – food - clothing - utensils - fuel - shelter – relief camp – sanitation and hygiene. Resilient farming concepts – reclamation and revival of the agriculture system after natural disaster (Bio-shield). Preparedness – Emergency Operations Centres (EOCS).

THEORY LECTURE SCHEDULE

1. Natural Disaster - meaning and nature of natural disasters, their types and effects.
2. Flood, drought, cyclone, earthquakes landslides, avalanches, volcanic eruptions, Heat and cold waves.
3. Climatic change- Global warming, sea level rise, ozone depletion
4. Manmade disaster - Nuclear disasters, chemical disasters, biological disasters.
5. Building fire, coal fire, forest fire. oil fire.
6. Air pollution, water pollution, deforestation, industrial wastewater pollution.
7. Disaster management- efforts to mitigate natural disasters at national and global levels.
8. India's key hazards, vulnerabilities and disaster response mechanism in India.
9. **Mid-Semester examination**
10. Concept of disaster management, national disaster management framework.
11. Financial arrangements, role of NGOs, community-based organizations and media.
12. Central, state, district and local administration.
13. Dissemination of disaster warning - response to natural disasters, national, state, district level.
14. Relief – food and nutrition – water – health – mental health services.
15. Rehabilitation – tolerant and resistant crops- resilient farming concepts – bioshields - livelihood options – insurance and compensation.
16. Disaster preparedness - clothing and utensils and fuel – shelter – relief camp – sanitation and hygiene.
17. Preparedness – Emergency Operations Centers (EOCS).

Course Outcomes:

CO 1: To learn different types of natural disasters

CO 2: To understand climate change, global warming and their mitigation

CO 3: To gain knowledge about disaster management and understand the importance of afforestation

CO 4: To acquire knowledge about disaster warnings

CO 5: To understand the importance of climate smart agriculture

CO- PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5
CO1	-	-	-	-	3
CO2	-	-	-	-	3
CO3	-	-	-	-	3
CO4	1	1		1	3
CO5	1	-	1	-	2

References

1. Gautam, D R. 2009. *Community based disaster risk reduction*. Mercy Corps, Lalitpur, Nepal.
2. Gupta, HK. 2003. *Disaster management*. Indian National Science Academy. Orient Blackswan.

3. Hodgkinson, PE and Stewart, M. 1991. *Coping with Catastrophe: A handbook of disaster management*. Routledge.
4. Ministry of Home Affairs. 2010. *Standard operating procedure for responding to natural disasters*, Ministry of Home Affairs – Disaster management Division, New Delhi.
5. Sharma, VK. 2001. *Disaster management*. National Centre for Disaster Management, India.
6. Das, H.P. 2016. *Climate change and agriculture implications for global food security*. BS Publications, Hyderabad.
7. Kelkar, R.R. 2010. *Climate change -A Holistic view*. BS Publications, Hyderabad.

e resources

1. [http:// research.un.org/en/disaste](http://research.un.org/en/disaste)
2. <https://searchworks.stanford.edu/>
3. <http://guodes.litrary.illinois.edu>c.php>
4. <http://libguides.aau.edu.au>c.php>
5. www.wcpt.org

PGS 717 Constitutions of India (1+0)

Learning Objectives:

- The main aim of this course is to make the students to understand the history of making of the Indian Constitution.
- This course will enable the students to know the philosophy of the Indian Constitution.
- This course will make the students to understand the nature of Indian Federalism, about the powers and functions of the President and Prime Minister of India.
- This course aims to sensitize the students on the administrative setup at the centre, state and local level.

Theory

Unit - I

Meaning of the Constitution law and Constitutionalism -Historical Perspective of the Constitution of India -Salient features and Characteristics of the Constitution of India.

Unit - II

Scheme of the Fundamental Rights. The scheme of the Fundamental Duties and its legal status. The Directive Principles of State Policy – Its importance and implementation.

Unit - III

Federal structure and distribution of legislative and financial powers between the union and the States-Parliamentary form of Government in India. The Constitution powers and status of the President of India. Amendment of the Constitutional Powers and Procedure.

Unit - IV

The Historical perspectives of the constitutional amendments in India. Emergency Provision: National Emergency, President Rule, Financial Emergency. Local Self-Government – Constitutional Scheme in India.

Unit - V

Scheme of the Fundamental Right to Equality. Scheme of the Fundamental Rights to certain Freedom under Article 19. Scope of the Right to life and Personal Liberty under Article 21.

Theory Lecture Schedule

1. Meaning of the Constitution law and Constitutionalism.
2. Historical Perspective of the Constitution of India.
3. Salient features and Characteristics of the Constitution of India.
4. Scheme of the Fundamental Rights.
5. The scheme of the Fundamental Duties and its legal status.
6. The Directive Principles of State Policy – Its importance and implementation.

7. Federal structure and distribution of legislative and financial powers between the union and the States.
8. Parliamentary form of Government in India
9. Mid- Semester Examination
10. The Constitution powers and status of the President of India.
11. Amendment of the Constitutional Powers and Procedure.
12. The Historical perspectives of the constitutional amendments in India.
13. Emergency Provision: National Emergency, President Rule, Financial Emergency.
14. Local Self-Government – Constitutional Scheme in India.
15. Scheme of the Fundamental Right to Equality.
16. Scheme of the Fundamental Rights to certain Freedom under Article 19.
17. Scope of the Right to life and Personal Liberty under Article 21.

Course Outcome:

CO 1: Understanding the history of making of the Indian Constitution

CO 2: Understanding the philosophy of the Indian Constitution.

CO 3: Understanding the nature of Indian Federalism, about the powers and functions of the President and Prime Minister of India.

CO 4: Make the students abreast of the administrative setup at the centre, state and local level.

CO -PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5
CO1	-	-	-	-	3
CO2	-	1	-	-	3
CO3	1	1	-	1	3
CO4	2	-	1	1	3

References:

1. Bipan Chandra, Mridula Mukherjee and Adility Mukherjee, 2016. **India after Independence 1947-2000**, Penguin Publishers New Delhi.
2. Durga Das Basu, 2018. **Introduction to the Constitution of India**. Prentice Hall New Delhi.
3. Granvila Austin, 2006. **The Indian Constitution: Cornerstone of a Nation**, New Delhi, Oxford University.
4. Paul R. Brass, 1999. **The Politics of India since Independence**. Cambridge New Delhi.
5. Yogendra Yadav (ed.,) 2000. **Transforming India: Social Dynamics of Democracy**: New Delhi, Oxford University.

Proforma-1**PROFORMA FOR FORMATION OF RESEARCH ADVISORY COMMITTEE**

(To be sent before the end of I Semester)

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

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

Signature of Professor and Head

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

*Proforma-1a.***PROFORMA FOR CHANGE IN THE RESEARCH ADVISORY COMMITTEE**

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

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

6. Reasons for change

Chairperson

Signature of Professor and Head

*Proforma-2***PROFORMA FOR OUTLINE OF RESEARCH WORK (ORW)**

(To be sent before the end of I Semester)

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

Signature of student

Approval of the advisory committee

Advisory committee	Name	Signature
Chairperson		
Members		
1.		
2.		

Professor and Head

*Proforma-2a***PROFORMA FOR CHANGE IN OUTLINE OF RESEARCH WORK (ORW)**

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

Signature of the student

Approval of the Advisory Committee

Advisory committee	Name	Signature
Chairperson		
Members		

Professor and Head

Proforma 3

DEPARTMENT OF -----
PROFORMA FOR EVALUATION OF SEMINAR

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

Distribution of marks	Max Marks					
i. Literature coverage	40					
ii. Presentation	30					
iii. Use of audio - visual aid	10					
iv. Interactive skills	20					
Total	100					
Name						
Designation		H.O.D	Chairperson	Member 1	Member 2	Average
Signature						

Grade point

Head of the Department

Proforma-4**PROFORMA FOR REGISTRATION OF RESEARCH CREDITS**

(To be given during first week of semester)

PART A: PROGRAM

Semester:

Year:

Date of registration:

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

Approval of advisory committee

Advisory committee	Name	Signature
Chairperson		
Members		
1		
2		

Professor and Head

Approval may be accorded within 10 days of registration

Proforma-5

PROFORMA FOR EVALUATION OF RESEARCH CREDITS

PART B EVALUATION

(Evaluation to be done before the closure of Semester)

Date of Commencement semester :

Date of closure of semester:

Date of evaluation:

1. Name of the student

2. Enrolment number:

Reg. No.:

3. Total research credits completed so far:

4. Research credits registered during the semester:

5. Whether the research work has
been carried out as per the approved :
program

6. If there is deviation specify the reasons :

7. Performance of the candidate : SATISFACTORY /NOT SATISFACTORY

Approval of the advisory committee

Advisory committee	Name	Signature
Chairperson		
Members		

Professor and Head

Proforma-6

PROFORMA FOR THE PROPOSAL OF QUALIFYING EXAMINATION

1. Name of the student:
2. Enrolment number: Reg. No.:
3. Degree:
4. Course:
5. Whether all major courses have been completed:
6. No. of credits completed:
7. Whether he/she has an overall GPA of above 6.5:
8. Title of thesis:
9. Panel of external examiners:
10. Remarks:

Signature of Chairman with
Name and designation

Professor and Head

Proforma-7**PROFORMA FOR COMMUNICATION OF RESULTS OF QUALIFYING EXAMINATION**

1. Name of the student:
 2. Enrolment number: Reg. No.:
 3. Degree:
 4. Course:
 5. Department :
 6. Date of examination:
 7. Result (Successful / not Successful*):
 8. Remarks:
- (*) to be written by the external examiner

Examination committee	Name	Signature
Chairperson		
Members		
External Examiner		

Professor and Head

Note if this is the re-exam the date of previous examination may be indicated

Proforma-8

ANNAMALAI UNIVERSITY
FACULTY OF AGRICULTURE
DEPARTMENT OF ENTOMOLOGY
PROFORMA FOR EVALUATION OF THESIS

1. Name of the examiner:
2. Postal Address:
3. Telephone/Mobile:
4. E-Mail:
5. Name of the candidate :
6. Title of the thesis:
7. Date of receipt of the thesis copy:
8. Date of dispatch of the detailed report and thesis by the examiner to the Controller of Examinations:
9. Examiner's recommendations choosing one of the following based on quality of thesis

Please give your specific recommendation (select any one decision from the list below) with your signature and enclose your detailed report in separate sheet(s).

a. I recommend that the thesis entitled -----

-----submitted by ----- be accepted for award of the Degree of MASTER OF SCIENCE (AGRICULTURE) of Annamalai University, Annamalainagar.

(OR)

b. I do not recommend the acceptance of the thesis entitled.

----- submitted by -----for award of the Degree of MASTER OF SCIENCE (AGRICULTURE) of Annamalai University, Annamalainagar. (Please specify reasons)

Date :

Signature with Office Seal:

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

*Proforma- 9***PROFORMA FOR REPORT OF THE FINAL VIVA VOCE EXAMINATION**

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

The following members were present:

1. ----- : Chairperson
2. ----- : Members
3. -----

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

The final viva voce examination for the candidate was conducted by the members of the
 Advisory Committee. The performance of the candidates was Satisfactory/ not Satisfactory.
 The Committee recommends/ does not recommend unanimously the award of Degree of
 M.Sc.(Ag.)/(Hort.)/Agri Business Management to Mr./Ms.-----

1. Chairperson
2. Member
3. Member

The original report from the External Examiner is attached herewith

Chairperson of the Advisory Committee

Professor and Head

*Proforma- 10***CERTIFICATE FOR HAVING CARRIED OUT THE SUGGESTIONS OF THE
EXTERNAL EXAMINER AND ADVISORY COMMITTEE**

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

Chairperson

Professor and Head

Proforma- 11



**FACULTY OF AGRICULTURE
DEPARTMENT OF ENTOMOLOGY**

CERTIFICATE

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

Chairperson

1. Member
2. Member