ANNAMALAIUNIVERSITY

(Accreditedwith'A+'GradebyNAAC)

FACULTYOFAGRICULTURE

(AccreditedbyICAR)

DEPARTMENTOFHORTICULTURE

Academic Regulations and Syllabi

DOCTOR OF PHILOSOPHY
VEGETABLE SCIENCE

Under Choice Based Credit System (CBCS) with Outcome based Education

2022-2023Onwards

COMMONREGULATIONSFORALLPh.D.PROGRAMMESOF FACULTY OF AGRICULTURE
(w.e.f.2022-2023)

1. DEFINITIONS

1.1 An**"Academicyear"** shallconsistoftwosemesters.

1.2 **"Semester"** means an academic term consisting of 110 instructional days excluding final theory examinations.

1.3 **"Course"** means a unit ofinstructionto be covered in a semester having specific No.,title and credits.

1.4 **"Credit hour"** means, one hour lecture plus two hoursoflibraryor homeworkortwo and half hours of library/field practical per week in a semester.

1.5 **"Credit load"** of a student during a semester is the total number of credits registered by that student during that particular semester.

1.6 "**Grade Point"** of a course means the value obtained by dividing the percentage of marks earned in a course by 10 and the Grade Point is expressed on a 10 point scale and rounded off to two decimal places.

1.7 **"CreditPoint"**meansthegradepointmultipliedbycorrespondingcredithours.

1.8 **"Grade Point Average (GPA)"** means the quotient of the total credit points obtained by a student in variouscoursesat theend ofeachsemester, divided bythetotalcredit hourstakenbythe student in that semester. The grading is done on a 10 scale and the GPAhas to be corrected to two decimals.

1.9 **"Overall Grade Point Average (OGPA)"** means the quotient of cumulative credit points obtained by a student in all the courses taken from the beginning of the first semester of the year divided by the total credit hours of all the subjects which he/she had completed up to the end of a specified semester and determines the overall performance of a student in all subjects during the period covering more thanone semester. The OGPA has to be arrived at the second decimalplace.

2. SYSTEMOFEDUCATION

2.1 These rules and regulations shall governthe Ph.D. programmes leading to the awardofDegree of Doctor of Philosophy in the concerned subject in the Faculty of Agriculture, Annamalai University. They shall come into force with effect from the academic year 2022-2023.

2.2 The semester system shall be followed for all the Ph.D. degree programmes. The duration of doctoral programmes is as follows:

2.2.1 Thedurationoftheprogrammeandthetime for admissionofthesisare countedfromthedate of provisional registration.

2.2.2 The minimum duration of the programme is three years and the maximum duration of the programme shall be seven years.

2.2.3 Break of study shall be granted up to a maximum period of one year and it can be done only aftercompletingthecoursework. Suchrequest shallbe made inadvance byscholar inwritingwith the recommendation of Supervisor, Head of the Department (HoD) and Dean, Faculty of Agriculture and it should reach the Director, Directorate of Academic Research (DARE). The orders for the

break of studyshall be issued by the Director, DARE after assessing the need.

2.2.4 If prior permission is not sought and obtained, it will be considered as a case of discontinuation and action will be taken to cancel the registration of such scholars.

2.2.5 Thescholarsshouldremittheyearlyfeesduringthebreakofstudyalso.

3. PROGRAMMES OFFERED

ThedetailsofvariousPh.D.programmesofferedintheFacultyofAgricultureareasfollows:

1. Agri-BusinessManagement
2. AgriculturalEconomics
3. Entomology
4. AgriculturalExtension Education
5. AgriculturalMicrobiology
6. Agronomy
7. GeneticsandPlantBreeding
8. FruitScience
9. VegetableScience
10. FloricultureandLandscaping
11. Plantation,Spices,MedicinalandAromaticplants
12. Plant MolecularBiologyandBiotechnology
13. Plant Pathology
14. SeedScienceand Technology
15. SoilScienceandAgriculturalChemistry

4. ELIGIBILITYFORADMISSION

CandidatesseekingadmissiontoPh.D.programme shouldsatisfythe following requirements.

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

4.2 Candidates who have undergone the programme under conventionalsystemshould possess not less than a second-class Master's degree. The candidates under trimester system should possess a minimumOGPAof3.00 out of4.00. Forthose under semester system7.00 out of10.00 isrequired for various Doctoral programmes.

EligibilityCriteria

DoctoralDegreeProgrammes	Eligibility
AgriBusiness Management	MBAinAgribusiness/MBAAgriBusiness Management
AgriculturalEconomics	M.Sc.(Ag.)inAgrl.Economics/Agricultural Marketing Management
Entomology	M.Sc.(Ag.)inEntomology/ AgriculturalEntomology
AgriculturalExtension Education	M.Sc.(Ag.)in AgriculturalExtension/Agricultural ExtensionandCommunication/AgriculturalExtension Education / Extension Education
AgriculturalMicrobiology	M.Sc.(Ag.)inAgriculturalMicrobiology
Agronomy	M.Sc.(Ag.)inAgronomy
GeneticsandPlantBreeding	M.Sc.(Ag.)inGeneticsandPlantBreeding
FruitScience	M.Sc.(Hort.)FruitScience
VegetableScience	M.Sc.(Hort.)Vegetable Science

Floriculture and Landscaping	M.Sc. (Hort.) Floriculture and LandscapeGardening/FloricultureandLandscapeArchitecture/FloricultureandLandscaping
Plantation,Spices, Medicinal and Aromatic plants	M.Sc.(Hort.)Plantation,Spices, Medicinal and Aromatic Crops
PlantMolecularBiologyand Biotechnology	M.Sc.(Ag.)inPlant MolecularBiology/Agricultural Biotechnology
Plant Pathology	M.Sc.(Ag.)inPlantPathology
SeedScience&Technology	M.Sc.(Ag.)inSeedScience&Technology
SoilScienceandAgricultural Chemistry	M.Sc.(Ag.)inSoilScienceandAgriculturalChemistry

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

4.3.1 The Ph.D. scholars shall report in the Department and sign every day in the attendance register. Inorderto promotequalityresearchand training incutting edge areas, the Universitymay permit the scholar to conduct research in recognised universities/research institutes, after the completion of qualifying Viva voce examination.

4.3.2 Project staff/ fellow working in projects in the University, sponsored by Government of India/ Industries / Government of Tamil Nadu can also register.

4.3.3 Candidatesinemployment should be sponsored bytheir employer and should avail leave for the minimum duration of the programme and should be formally relieved from their duty to register.

4.3.4 Candidates who are selected under the national level fellowship programmes or by any recognized bodiesand who satisfythe eligibilityconditionsasper the regulations shallapply in the respective discipline.

4.3.5 AdmissiontoForeignStudents:Foreignstudents, who areselectedunder variousscholarship schemes, either by the Ministry of Education and Culture or by the Ministry of External Affairs, will be given admission on the recommendation / sponsorship of the respective Ministry of Government of India. The other foreign students who seek admission should possess a research VISA issued by the Indian Embassies aboard and produce “No Objection Certificate” from the Ministry of Human Resource Development, Government of India, after clearance from theMinistry of External Affairs. They should also show proof for financial capability for staying, pursuing Ph.D. programme for three years.

5. MODEOFSELECTION

5.1 UniversityshallissuenotificationforPh.D. admission instartingofacademicyear.

5.2 The candidates desirous of registering for Ph.D. programme shall apply by filling all the relevant details mentioned in the online application form posted in the University website and submit completedapplicationonline beforetheduedateasindicated inthe notificationissued from time to time.

5.3 Incomplete applications and applications with false information in any respect shall be summarily rejected without any intimation to the candidate.

5.4 The Departmental Research Committee (hereafter referred to as DRC) of concerned

Department shall screen the applications as per the eligibility norms and shall conduct the written test and interview only for eligible candidates.

5.5 The admission to Ph.D. students shall be based on the following criteria besides general eligibility.

5.5.1 An entrance test at post graduate level for 70 marks (70 multiple choice questions (MCQs), each question carrying one mark and duration of the test is 90 minutes followed by an interview that will have a weightage of 30 marks.

5.5.2 The candidates who secure 50% marks in entrance test and interview are eligible foradmission.

5.5.3 Arelaxationof5 % marks (from50 %to 45%) shall be allowed forthe candidates belonging to SC/ST/OBC (non creamy layer)/ differentially able category.

5.5.4 Candidates with UGC- JRF / NET / ICAR/ICSSR qualified candidates and teacher fellowship holders are exempted from the Entrance test but they have to appear for the interview and evaluated for 100 marks.

5.6 Departmental Research Committee: The following is the constitution of the DRC. Themembers other than Head of the Department shall serve only for one academic year.

Designation	Members
HeadoftheDepartment	Convener
TwoprofessorsSeniorFacultynominatedbytheVice-Chancellor in rotation	Members
One AssociateProfessor(inrotation)	Member
OneAssistant Professor(inrotation)	Member

5.7 TheDRChasthefollowingfunctions

5.7.1 Selectionofcandidatesforadmissiontothe Ph.D.programme.

5.7.2 FacilitatingresearchfacilitiesintheDepartment.

5.7.3 Maintenanceofresearchqualityandquality ofpublications.

5.7.3 Sortingoutanyother researchrelatedissueoftheDepartment.

5.8 If there is any dispute either in the constitution of functioning of the DRC, it shall be brought to the notice of the Director, DARE and the decisionof the Vice-Chancellor shall be final.

5.9 The minutes of the DRC together with the list of selected candidates and their research supervisors along with recommendations of the Dean of the respective faculty will be placedbefore the Vice-Chancellor for approval.

6. ADMISSION

6.1 TheselectedcandidatesshallbeissuedadmissioncardsandtheywillbeadmittedtoPh.D. programme intherespectiveDepartment basedonhis/herPGqualification,entranceand interview.

6.2 TheprovisionalregistrationorderforPh.D.shallbeissuedtothecandidates.

6.3 Thescholar,supervisor,Research AdvisorCommitteemembersandexaminersshall notbe relatives to one another.

7. TUITIONFEESANDOTHER FEES

7.1 The selected candidates shall pay the prescribed fees before the last date mentioned in the selection order, failing which they will forfeit the seats.

7.2 The yearly fees shall be paid bythe scholars within the prescribed datetill the scholar submits the thesis. The supervisors should monitor the regular payment of yearly fees by those scholarswho are working under them.

7.3 The registration is liable for cancellation, if the research scholar has not paid the yearly fees within stipulated time.

7.4 Non-payment of yearly fees is a serious lapse onthe part of the scholars. Explanation for non-payment of yearly fees shall be called for from the supervisors.

7.5 Thevariousfeespayablebythestudentswillbedecidedbytheuniversityfromtimeto time.

7.6 Admission to the hostelwill be strictlyrestricted to the actualaccommodation available and no associate will be allowed. A Ph.D. student may be allowed to stay in the hostel for a maximum of five years from the date of admission to the Ph.D. programme.

8. CREDITGRADEPOINTREQUIREMENTS

8.1 A student enrolled for Doctoral program is required to complete 100 credits inclusive of 75 credits of research to become eligible for the degree as detailed below:

Details	CreditHours
Major Courses	12
Minor Courses	6
SupportingCourses	5
Seminar	2
Research	75
NoncreditCompulsorycourses-ResearchandPublicationEthics(Contacthours:2) MOOC (Contact hours: 2)	
Total	**100**

8.2 In a semester, a Ph.D. scholar can register a maximum of 15 credits excluding research. However, the research credits registered should not exceed 16 per semester. Semester-wise distribution of credits is given in the respective Ph.D. programmes.

8.3 Registration Card: A student shall register the courses offered in a semester by writing all the courses in registration card in quadruplicate. The Supervisor, Ph.D. Coordinator and Head of the Department are responsible to furnish the registration particulars of the students with theirsignature in the Registration card to the Dean. The Dean shall approve the registration cards. The approved registrationcardsshall be maintained bythe HoD, Supervisor and the student concerned. The list of courses registered by the students in each semester shall be sent by the Dean to the DARE for preparation of Report Cards.

8.4 The Ph.D. students should complete their course work within the first two semesters in Annamalai University campus.

8.5 Requirements for Ph.D. programme shall also include successful completion of Non-Credit Compulsory Courses, thesis research in the major field of study and submission of thesis thereon.

9. ATTENDANCEREQUIREMENT

9.1 One hundred per cent attendance is expected from each scholar. A student who fails to secure 80 per cent ofattendance in each subject separately for theoryand practical, shall not be permitted to appear for the final examination in that subject and shall be awarded 'E' (incomplete) and willbe required to repeat the course whenever offered.

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

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

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

9.5 Inrespectofstudents who had absented for the mid-semester examination (MSE)onuniversity business with prior permission of the HoD and Dean, Faculty of Agriculture, the makeup first test should be conducted ordinarilywithin 15 working days from the date of conduct of the first test.

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

10. RESEARCHADVISORYCOMMITTEE

10.1 Each Ph.D. scholar shall have a Research AdvisoryCommittee (RAC) to guide the scholar in carrying out his/her programme.

10.2 A Research Advisory Committee shall be constituted with the approval of the University for each candidate separately, immediately after his/her admission.The purpose of the RAC is to provide expert opinion on frontline research.

10.3 There shall be a Research AdvisoryCommittee for everystudent consisting ofnot fewer than four members withthe Supervisor asChairperson. The Research AdvisoryCommittee should have representatives from the major and minor fields. The Research Supervisor should convene a meeting of the Research Advisory Committee at least once in a semester. The research credit evaluation form should be communicated to the Head of Department and the Director, DARE for information.

10.4 ResearchSupervisor

10.4.1 Everyscholar shall have a ResearchSupervisor (among the recognized guides), who will be appointed by the Vice-Chancellor on the recommendation of the DRC, Head of the Departmentand the Dean, Faculty of Agriculture. Research supervisors approved by the Vice-Chancellor only can be the guide for the students.

10.4.2 A teacher having Ph.D. with 5 years of service and PG teaching is eligible for teaching and

guiding Ph. D. scholars. A teacher should have a minimum of three years of service before retirement for allotment of doctoral candidates.

10.4.3 The research supervisors who wish to avail leave/lien/deputation beyond a period of six months shall propose a Co-supervisor in the concerned subject for the candidates registered with themand it may be intimated to the Universitywell in advance. The finalapprovalof the proposal rests with the Vice-Chancellor.

10.5 FunctionsoftheRAC:

10.5.1 Discuss, advice and recommend on all matters connected with the scholar's research from admission till the completion of the programme.

10.5.2 Approvethetopic ofresearchandthe synopsis.

10.5.3 Assess and approve the progress reports of Ph.D. scholars in the prescribed format and to reporttotheUniversityonthefitnessorotherwise ofthecandidatetoproceedwithhis/her research work for the Ph.D.

10.5.4 If necessary, recommend and approve change of title of dissertation / thesis and change of Research Supervisor.

10.5.5 Conduct the pre-submission presentation (before the submission of synopsis) and to give a certificate to this effect to be submitted along with the synopsis.

10.6 TheResearchAdvisoryCommitteewillmeeteverysemester

10.6.1 Toscrutinizetheresearchproposal/progressreport submitted bytheresearchscholar.

10.6.2 To assess the conduct of experiments / field work, peruse laboratory notebooks, data recording, analysis, and publication.

10.6.3 Toreviewand endorsetheannualprogressreport oftheresearchscholar.

10.6.4 Toapprovethesynopsisofthethesis.

10.6.4 The Chairperson will convene the Research Advisory Committee meetings with intimation to the Director, DARE through the Head of the Department.

10.7 ChangesinRAC

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

10.8 ChangeofResearchSupervisor

10.8.1 Change of Research Supervisor shall not be permitted as a routine. In exceptional cases, such change may be permitted, if valid reasons are provided by the candidates. The Committee headed by the Vice-Chancellor shall look into the request of the petitioner, if there is any conflict between the scholar and the research supervisor.

10.8.2 The Research Supervisor under whomthe scholar has originallyregistered shall give a "No Objection Certificate" and the new proposed Research Supervisor should give a "Certificate of Willingness" to guide the candidate. The finaldecision willrest with the University. However, the Vice-Chancellor, on the recommendation of the RAC and Dean's Committee, has the right to assign a new research supervisor to the research scholar.

10.8.3 When the change of Research Supervisor is approved, the candidate shall work for a minimumofone year withthe new ResearchSupervisor, ifthe topic ofhis/her research is different under the new supervisor, provided he/she fulfils the attendance requirements.

10.9 Change of Topic of Research

10.9.1 Change of the specific area of research may be permitted within one year from the date of admission and request must be submitted with the recommendations of the RAC. In such cases,

the minutes of the RAC meeting must include whether the course work undertaken by the research scholar is relevant to the new research area and the competence of the research supervisor in this field.

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

10.10 AbsenceofMemberduringQualifying /FinalViva-Voce Examination

Underextra-ordinarycircumstancesifthequalifying / finalviva-voceexaminationto Ph.D. student has to be conducted in the absence of one or two RAC members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Director, DARE in advance.

11. EVALUATIONOFSTUDENT'SPERFORMANCE

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

12. EXAMINATIONS

12.1 There will be two examinations viz., first test and finalexamination. Wherever the course has practical, there will be a final practical examination also.

12.2 The durationof first test will be ofone and half anhour and finalexaminations intheoryand practical will be conducted for three hours each.

12.2.1 The first test will be conducted bycourse teachers during the ninth week of the semester as per the scheme drawn by HOD, evaluate and send the marks obtained by the students to the Director, DARE through HOD within seven working days.

12.2.2 The question paper for the final examination will be set as per Bloom's taxonomy by the concerned course teacher in consultation with the Head of the Department.

12.2.3 There will be final examination separately for theoryand practical which will be conducted bytheUniversity. Each finaltheoryand practicalexaminationswill beevaluated bytwo examiners (one will be the course teacher and another will be among the senior facultyof the Department). The distribution of marks will be as indicated below:

S.No	Examination	Coursewith practical	Coursewithout practical	Course withouttheory
1	First Test	30	30	30
2	Finaltheory	40	70	-
3	Finalpractical	30	-	70
	Total	**100**	**100**	**100**

The question paper modeland distribution of marks for first test and finaltheoryexaminations are as follows:

FirstTest(30marks)(1.5hoursduration)

1	Definitions/concepts	5outof7	(5x1)	5marks
2.	Short notes	5outof7	(5x3)	15marks
3	Essaytype	2outof3	(2x5)	10marks

FinalTheory: Coursewithoutpractical(70marks)(3hoursduration)

1.	Short notes	5outof7	(5x4)	20marks
2	Essaytype	5outof7 (Fourquestionsmustrepresent K6 level of Bloom's taxonomy)	(5x10)	50marks

FinalTheory: CoursewithPractical(40marks)(3hoursduration)

1.	Short notes	5outof7	(5 x2)	10marks
2	Essaytype	5outof7	(5x6)	30 marks

12.3 MinimumMarksforPass

12.3.1 The student should secure a minimum of 60 per cent marks separately in the theory and practical and an aggregate of 70 per cent to secure a pass in the subject. Each subject shall carry a maximum of 100 marks for purpose of grading. The grading will be done as grade point, i.e., the percentage of marks earned in a subject is divided by 10. The grade pointis expressed on a 10 point scale upto two decimals.

12.3.2 Students who secure marks below 70 per cent in a subject will be awarded 'RA' grade and students without having the required minimum attendance of 80 per cent will not be allowed to write the final examination and they will be awarded 'E' grade. Students who secure 'RA' grade should appear for re-examination inthe subsequent semester. Ifa student secured 'E'grade,he/she has to re-register and attend the course again during the next academic year.

12.4 MinimumGPARequirement

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

a. EarnaGradePoint of7.00 forapassineachsubject.
b. For purpose of continuing as a student in the university, a candidate is required to earn a Grade Point Average of not less than 7.00 at the end of each semester.
c. A Ph.D. student may repeat the course (s) in which he/she gets a Grade Point below 7.50 and above 7.0 to improve the OGPA.

12.5 Re-Examination

12.5.1 Re-examination is permitted only for the final theory and practical examinations. The students who secure 'RA' grade are permitted to write the re-examinations as and when conducted with the permission of university.

12.5.2 The re-examination fee as prescribed byuniversityper course is to be paid on or before the prescribed date. A student is permitted to write the final theory and practical examinations onlytwo times during the course period of three years excluding the regular final examination.

12.5.3 In the event of a student who fails to secure a pass in the two re-examinations permitted, he/she has to re-register for the course along with juniors. The marks secured in first test will be retained and the student should produce the practical record during re-examination. Theregistration for the re-examination shall be done after first test on the date specified by theDirector, DARE. Each registration is considered as an attempt even if the student absents for the examination.

12.6 ReturnofValuedAnswerPapers

12.6.1 The valued answer papers of first test shall be shown to the students after the examination. Discrepancies if any, in awarding marks, the student can approach the teacher concerned immediately for rectification.

12.6.2 The answer paper should be retained with the course teacher for six months and then disposed off. Evaluated final theory papers have to be retained up to six months by the Director, DARE after the conduct of examination and then disposed off.

13. SEMINAR

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

13.1 SeminarTopic

13.1.1 The seminar topic should be only fromthe major field and should not be related to the area ofthesisresearch. The seminar topicsareto beassigned to thestudentsbythe ResearchSupervisor in consultation with HOD within three weeks after commencement of the semester.

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

13.1.3 The circular onthe presentationofthe seminars may be sent to other Departments to enable those interested to attend the same.The Research Supervisor will monitor the progress of the preparation of the seminar and correct the manuscript.

13.1.4 The student will submit two copies of the corrected manuscript to the HOD through Research Supervisor before presentation. The student will incorporate the suggestions and carryout corrections made during the presentation and resubmit three fair copies to the HOD (one to Dept. library, the second to the Research Supervisor and the third for student) within 15 days after presentation.

13.1.5 The performance of the student in the credit seminar will be evaluated and grade point

awarded by the HOD along with the RAC for 100 marks. Grade Point may be given based on the following norm.

Details	Marks
Coverageofliterature	40
Presentation	30
Useofaudio-visual aids	10
Capacitytoparticipateindiscussionandanswerthequestions	20
Total	**100**

14.QUALIFYINGEXAMINATION

Only those students who successfully complete the qualifying examination will be admitted to candidacy of the degree. The qualifying examination consists of only Viva-voce examination. The qualifying examination should be conducted before fourth week from the commencement of the third semester.

14.1 Minimumrequirement forqualifyingViva-voceExamination

Thestudentswhohavecompletedall thecoursesandearnedagradepointaverageofnotlessthan 7.0 will be permitted to appear for the qualifying examination. Students who do not satisfy these requirements shall not be permitted to take up the qualifying examination. The qualifying examination will be conducted after the successful completion of course work.

14.2 SelectionofExaminer

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

14.3 QualifyingViva-VoceExamination

14.3.1 The evaluation should cover both the research problem and theoretical background to executetheproject.Thisshallassesstheaptitudeofthestudent and suitabilityofthestudent forthe given research topic.

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

14.3.3 The Headofthe Department will monitor and coordinatethe conductof the qualifying viva. The performance of the candidate will be graded asSatisfactory / Unsatisfactory.

CommunicationofResultsofQualifyingExamination

The Research Supervisor shall act as chairman for the examination committee and shall be responsible for communicating the resultsofthe examinationto the Director,DARE throughHOD in the prescribed format.

14.5 **Failure/AbsenceinQualifying Examination**

14.5.1 When a student fails or absents for the qualifying examination, he/she may apply again for permission to appear for re-examination to the Director, DARE with the recommendation of the RAC and Head of the Department.

14.5.2 A student, who applies for re-examination should attend viva-voce. Re-examination shall not take place earlier than one month after the first examination. It will be conducted by the RACas previously indicated.

14.5.3 If a student fails in the re-examination, further re-examination will be considered on the

recommendation of the RAC, HoD and Dean, Faculty of Agriculture. If the student fails in the qualifying examination, he/she is not permitted to register for further research credits in the next semester.

15. THESISRESEARCH

15.1SelectionofTopic

15.1.1 The thesis research for the Ph.D. degree should be ofthe natureofa definite contribution to the subject and the results should be of sufficient importance to merit publication. The findings should have some practical utility or should lead to theoretical contribution.

15.1.2 Thethesis shall be onatopic falling within the field ofthe major specializationand shall be the result ofthe student's ownwork. Acertificateto this effect duly endorsed bythe major advisor shall accompany the thesis.

15.2 ResearchProposal

15.2.1 The researchscholars shallpresent their broad areaofresearchand submit a proposalto the Research Advisory Committee at the end of the first semester.

15.2.2 Theresearchproposalhasto bepresentedbythestudent ina meetingorganized bytheHead of the Department to get the opinion / suggestion of the faculties of the Department for improving it. Three copies of the research proposal in the prescribed format should be sent to the Director (DARE) through the Head of the Department for approval.

15.2.3 Thedistributionofresearchcreditwillbeasfollows:

Semester	CreditHours
ISemester	0+2
IISemester	0+10
IIISemester	0+16
IV Semester	0+16
VSemester	0+16
VISemester	0+15
Total	**0+75**

15.3 EvaluationofThesis Research

15.3.1 After assigning the researchproblem, for eachsemester,the student hasto submit a detailed programme of work to be carried out by him/her during the semester in the prescribed proforma. After scrutiny and approval, a copy of the research programme has to be given to the student for carrying out the work during that semester.

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

15.3.3 The student has to submit his/her research observation note book to the Research Supervisor, who will scrutinize the progress and sign the note book with remarks as frequently as possible. This note book will form the basis for evaluation of research progress.

15.3.4 After completion of 80% attendance for research and on or before the last day of the semester, the research scholars, shall submit Progress Reports in the prescribed format duly endorsed by the Research Advisory Committee to the Director, DARE until they submit their synopsis.

15.3.5 Failuretosubmittheprogressreportsshallentailautomaticcancellationofregistration.
15.3.6 The minutesofthe meeting ofthe Research AdvisoryCommittee along withenclosures will be sent to the Director, DARE.
15.3.7 Candidates who are recipients of fellowships such as JRF/SRF directly from any of the funding agencies/ shall send the progress reports and the utilization certificates in the format prescribed by the respective funding agency through proper channel.
15.3.8 The procedure of evaluating research credits under different situations are explained hereunder.

SITUATION–I

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

SITUATION–II

The student who has not secured the minimum attendance of 80 per cent shall be awarded grade 'E'. The student has to re-register the same block of research credits for which 'E' grade was awarded earlier in the following semester with prior permission. Until the completion of re-registered credits, the student should not be allowed to register for fresh (first time) researchcredits.

SITUATION–III

The studentcould not complete the research as per the approved programme of work for reasonsbeyond his/her control such as,

- Failureofcrop
- Non-incidenceofpestsordisease orlackofsuchnecessaryexperimentalconditions.
- Non-availabilityoftreatmentmaterialslikeplantingmaterialschemicals,etc.
- Anyotherimpeding/unfavorablesituationforsatisfyingtheadvisorycommittee.
- Underthesaidsituations, grade**EE**shouldbeawarded.

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

SITUATION–IV

Whenthe student fails to complete the work even inthe 'second time'registration, the student will be awarded **UNSATISFACTORY** and, in the mark, list the 'second time' should be mentioned.
For the registration of research creditsfor the third time,permission hastobe obtainedfrom the Dean based on the recommendation of the RAC, and HOD.
Permission for registration for thefourth time shall be given only by the University based on therecommendation of the RAC, HOD and Dean, Faculty of Agriculture.

16. SUBMISSIONOFTHESIS

16.1 The researchcredits registered inthe last semester should be evaluated onlyat the time ofthe submission of thesis, bythe RAC. Students can submit the thesis at the end of the final semester.
16.2 If a student has completed the thesis before the closure of the final semester, the research supervisor can convene the RAC meeting and take decision on the submission of the thesis,

provided the student satisfies 80 per cent attendance requirement.

16.3 The candidate shall be allowed to submit his/her thesis after the completion of stipulated period. Agraceperiodof90days maybeallowedto submit thethesisafterthepresprescribedduration. Ifthethesis is not submitted evenafter the grace period,the student shallpaythe tuitionfee forthe ensuing year.

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

16.5 Three copies of the thesis (in the approved format) shall be submitted together with the submission fee not later than three months after the submission of the synopsis.

16.6 No dues certificates from the Department and Central Libraries, Hostel, Stores, etc. must be submitted with the thesis copies. The Research Supervisor shall forward the thesis copies with the enclosures to the Director, DARE through the HOD and the Dean.A softcopy of the thesis in PDF format as prescribed by Shodhganga, shall also be submitted.

16.7 ThePh.D. scholarshaveto publisha minimumoftwo researchpapers inNAASratedjournals with5andaboverating(forsocialscienceNAASratedjournalswith4andaboverating)/Scopus / Web of Science indexed journals at the time of publication of the papers. The synopsis will be accepted for processing onlyafter showing evidences for publications oftwo suchresearchpapers.

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

16.9 Pre-submissionPresentation

16.9.1 The pre-submission presentation of the thesis is a requirement to enrich the scholar and to fine tune his/her research presentation. This presentation shall be conducted before the submission of the synopsis in the presence of the RAC, Supervisor/Co-Supervisor, HoD, Faculty members, Research Scholars and/or P.G. Students.

16.9.2 The scholar shall present the findings. The gathering may suggest ideas / references to be consulted / suggestions to improve the work.

16.9.3 A report on this event along with an attendance sheet shall be forwarded by the Research Supervisor with the endorsement of the RAC and HOD to the Director, DARE.

16.10 SubmissionofSynopsis

16.10.1 The submission of synopsis may be permitted 3 months before the completion of required duration on successful completion of course work.

16.10.2 The Research Scholar shall submit 3 copies of the synopsis approved by the Research Advisory Committee along with a soft copy to the Director, DARE through the Research Supervisor, the HOD and Dean of the respective Faculty.

16.10.3 Guidelines for the preparation of the synopsis are appended in Appendix I. Name of the candidate and name of the supervisor shall not be mentioned anywhere in the synopsis; enrolment number of the candidate alone shall be given. A model cover page for a synopsis is given in Appendix III.

16.11 GuidelinesforPreparationofThesis

16.11.1 The thesis shall not exceed 250 pages excluding the Bibliography, Appendices, etc. If it exceedsthe specified number ofpages, the ResearchSupervisor should write to universitywiththe reasons and get prior approval from the University. The candidate shall pay a penalty for theexcess number ofpages as decided bythe Deans Committee.The thesis should be in A4 size.

16.11.2 The specification for the preparation of the thesis is given in Appendix II. A model cover page for a thesis is given in Appendix IV.

The thesis shall be typed on both sides of the page in order to save paper and postage. The thesisshallcontainaCertificatefromtheguide(Annexure) specifying that thethesissubmitted is arecord of research work done by the candidate during the period of study under him/her andthat the thesis has not previously formed the basis for the award of any Degree, Diploma, Associate ship, Fellowship or similar title.

16.11.3 Astatement fromtheguide indicatingthe extent to whichthe thesisrepresentsindependent work on the part of the candidate should also be made. (Appendix V)

17. VALUATIONOFTHETHESIS

17.1 PanelofExaminers

17.1.1 The thesis submitted in partial fulfilment of the Ph.D. degree shall be evaluated by two external experts one from within the country and the other from outside the country appointed by the Vice-Chancellor on the recommendation of the Research Supervisor of the RAC, HOD and Dean.

17.1.2 The external experts shall be chosen from a panel of at least five names of specialists separately fromwithin the countryand outside the country in the particular field, suggested bythe Research Supervisor.

17.1.3 The externalexperts shall send their evaluation reportsonthe thesis directlyto the Director, DARE along with the copy of the evaluated thesis. The Director, DARE on receipt of the reports fromthe two examiners will send themto the concerned Research Supervisor who is the convener of viva-voce board.

17.1.4 The Research Supervisor will send the consolidated report with his remarks to the Director, DARE through the Head of the Department. Based on the satisfactory reports of the evaluation, Viva-voce examination will be arranged.

17.1.5 After a student's thesis for Ph.D. degree is evaluated as indicated above, the thesis shall be finally accepted for the award only after the student satisfactorily completes the final Viva-voce examination.

17.1.6 The Viva-Voce board comprises the student's RAC with the addition of the external examiner who valued the thesis, and the HOD. Ifthe HOD happens to be the ResearchSupervisor, the Dean, Faculty of Agriculture will nominate a senior member of the staff of the concerned Department as a member.

17.1.7 The candidate is expected to defend the thesis at the Viva-voce examination. The degree shall be awarded on the unanimous recommendation of the Viva-Voce board as **satisfactory** with regard to the thesis and the performance of the student in the final Viva-voce examination.

17.1.8 The recommendation of the Viva-Voce board shall be forwarded to the Director, DARE by the Research Supervisor through HOD and Dean which shall be signed by all members of the committee and the external examiner.

17.1.9 A candidate who is not successful (unsatisfactory) at the Viva–voce examination will be permitted to undergo the Viva-voce examination again within a period of three months

17.2RevisionandResubmissionofThesis

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

17.2.2 If the thesis is recommended to be revised by one or both examiners, the points of revision willbeindicatedclearlyinthereport.Thenecessarycorrectionshouldbecarriedout,andthe revised version should be sent to the concerned examiner(s). If the examiner(s) is / are still not satisfied with the revised version, the thesis will be rejected. If the thesis is accepted by the examiners (Evaluation), Viva–Voce examination will be conducted by the viva-voce board.

17.3 Re-registrationandSubmissionofThesis

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

17.4 ExtensionofTime

17.4.1 Researchscholarswho do not submit thethesiswithinthestipulatedperiodshouldapplyfor extension of time three months before the completion of three years.Extension of time and the fees to be paid will be considered by the Deans Committee, if the extension is duly recommended bythe RAC, Head ofthe Department, and the Dean ofthe Faculty, such candidates will be eligible for extension of time for a maximum period of three years.

17.4.2 The scholar will have to enrol as fresh candidates if he/she fails to submit the thesis within the maximum extension period of three years when granted.

17.4.3 If a scholar requires a few more months after the expiry of the maximum extension periodofthree years for the submission ofthe thesisasper the evaluationofthe RAC, dulyrecommended by the Head of the Department and the Dean of the Faculty, as an exceptional case, the Deans committee may consider for re-registration to enable the scholar to submit the thesis. In any case, the time granted shall not exceed six / twelve months.

17.5 NumberofChances

17.5.1 A candidate will not be permitted to submit a thesis for the degree on more than two occasions. However, it will be open to the Syndicate, ifthe Board ofExaminers so recommend, to permit the candidate to submit a thesis on a third occasion.

17.5.2 Also, he / she will not be permitted to appear for the viva-voce examination on more than two occasions.

18. DISCONTINUANCEANDREADMISSION

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

18.2 After completion of course work and qualifying examination, a student is eligible to discontinue temporarily his research program only once within 5 years for Ph. D. program. If the

discontinuationperiodexceedstwo semesters, thestudent hasto foregotheresearchcreditsalready registered and register afresh with revised program.

18.3 Inthe case of field experiments or laboratory experiments in which continuity is essential for research and if a student temporarily discontinues in the middle without completing the experiments,thenthe entire experiment should be repeated,even ifthe discontinuationperiod does not exceed two semesters.

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

Ph. D.Vegetable Science

SemesterwiseDistributionofCredit

Semester	Major Course	Minor Course	Supporting Course	Seminar	Research	Total credit	NoncreditCompulsory course
I	6	3	2	1	2	**15**	-
II	6	3	3	1	10	**22**	-
III	-	-	-	-	16	**16**	ResearchandPublic Ethics
IV	-	-	-	-	16	**16**	**MOOC**
V	-	-	-	-	16	**16**	-
VI	-	-	-	-	15	**15**	-
Total credit	**12**	**6**	**5**	**2**	**75**	**100**	**-**

Distributionof Courses

Course code	Course Title	Credithour (Theory +Practical)
	MajorCourses	12
VSC 601*	Recenttrendsinvegetable production	3(3+0)
VSC 602*	Advancesinbreedingof vegetable crops	3(3+0)
VSC 603	Abioticstressmanagementinvegetable crops	3(2+1)
VSC 604	Seedcertification, processingandstorageof vegetable crops	3(2+1)
VSC 605	Breedingforspecial traitsinvegetablecrops.	3(2+1)
	Minor Course	6
VSC 606	Biodiversityandconservationofvegetable crops	3(2+1)
VSC 607	Biotechnologicalapproachesinvegetable crops	3(2+1)
VSC 608	Advancedlaboratorytechniquesforvegetable crops.	3(1+2)
	SupportingCourses	5
COM601	AdvancesinComputerApplications	2(1+1)
STA601	AdvancesinDesignsof Experiments	3(2+1)
	Seminar	
VSC 691	DoctoralSeminar–I	1(0+1)
VSC 692	DoctoralSeminar–II	1(0+1)
	Research	**75**
VSC694	DoctoralResearch	0+2
VSC695	DoctoralResearch	0+10
VSC696	DoctoralResearch	0+16
VSC697	DoctoralResearch	0+16
VSC698	DoctoralResearch	0+16
VSC 699	DoctoralResearch	0+15
	Noncreditcompulsory courses	
NGC611	Research andPublicationEthics–Contacthours:2	-
NGC612	**MOOC–Contacthours:2**	-

SemesterwiseDistribution ofCourses

Sl.No	Courses	CreditHours
I	**FirstSemester**	
1	MajorCourses	6
2	Minorcourses	3
3	COM601AdvancesinComputerApplication	1+1
4	VSC691 Seminar	0+1
5	VSC694Research	0+2
	Totalcredits	**0+14**
II	**SecondSemester**	
1	MajorCourses	6
2	Minorcourses	3
3	STA601AdvancesinDesigns ofExperiments	2+1
4	VSC692 Seminar	0+1
5	VSC695Research	0+10
	Totalcredits	**0+23**
III	**ThirdSemester**	
1	ResearchandPublicEthics*	2+0
2	VSC696Research	**0+16**
IV	**FourthSemester**	
1	MOOC*	2+0
2	VSC697Research	**0+16**
V	**FifthSemester**	
1	VSC698Research	**0+16**
VI	**SixthSemester**	
1	VSC699Research	**0+15**
	Grandtotal	**100**

*Noncreditcompulsorycourse.

DEPARTMENTOFHORTICULTURE

Ph. D.VegetableScience

PROGRAMMEOUTCOME

PO 1 – The scholar will acquire knowledge on crop improvement, production technologies, biotechnology and postharvest technologies pertaining to vegetable cropswith special reference to advancement in research.

PO 2 – The scholar will gain skills in approaching research problems and define research methodology for problems solving research in the field of vegetable science.

PO3–Thescholarwillbeabletodoindividualresearchworksinvegetablecrops.

PO 4 – The scholar will become eligible to work in research programmes offered by national and international organizations and in teaching vegetable science.

PO 5 – The scholar will be able to develop expertise in scientific writing and publication of a research outcome.

VSC-601RECENTTRENDSINVEGETABLEPRODUCTION(3+0)

Learningobjectives

- Toupdatethestudentswithlatestdevelopmentsandtrendsinproductiontechnologyof vegetable crops.
- Toimpartknowledgeaboutpresentstatusandprospectsofvegetablecultivation.
- TogainknowledgeaboutHi-Technurserymanagement.
- Tolearnaboutthemodernconceptinwater&WeedManagement.
- ToacquireKnowledgeandskillabouttherecenttrendsinnutrientmanagement.

Theory

Presentstatusandprospectsofvegetablecultivation;nutritionalandmedicinalvalues; climate and soil as criticalfactors invegetableproduction;choice of varieties; nursery management;modernconceptsinwaterandweedmanagement;physiologicalbasisofgrowth, yield and quality asinfluencedbychemicalsand growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrientmanagement, nutritional deficiencies, disorders and correction methods;different cropping systems; mulching; containerized culture for year roundvegetable production; low costpolyhouse;nethouse production; cropmodeling,organic gardening;vegetable production for pigments, export and processing.

Unit-I: Solanaceous andmalvaceous vegetables

Tomato,brinjal,chilli,sweetpepper,potatoandbhendi.

Unit-II:Colecropsandcucurbits

Cabbage,cauliflower,knol-khol,sproutingbroccoliandcucurbits.

Unit-III:Leguminousvegetablesandgreenleafyvegetables.

Peasandbeans,amaranthusanddrumstick

Unit-IV:Rootcropsandbulbs

Carrot,beetroot,radishandonion.

Unit-V:Tubercrops

Sweetpotato,tapioca,dioscorea,elephantfootyamandtaro

Lesson plan

1.Presentstatus andprospectsofvegetablecultivation; nutritional andmedicinalvalues;
2-3. Tomato
4-5.Brinjal
5.Chilli
6-7.Sweetpepper
8.Potato
9-10.Bhendi
11-12.Cabbage
13-14.Cauliflower
15. Knolkhol

16. Sproutingbroccoli
17. Pumpkin
18. Ashgourd
19. Bittergourd
20. Ridgegourd
21. Bottlegourd
22. Snakegourd
23. Cucumber
24. Watermelon
25. **FirstTest**
26. Muskmelon
27. Pointedgourd
28. Turnip
29. Peas
30. Frenchbean
31. Clusterbean
32. VegetableCowpea
33. Amaranthus
34. Drumstick
35-37.Carrot
38. Beet root
39. Radish
40-41.Onion
42. Aggregatumonion
43. Tapioca
44. Sweetpotato
45. Dioscorea
46. Elephantfootyam
47. Containerizedcultureforyearroundvegetableproduction
48. Low-cost polyhouse;nethouseproduction;cropmodelling,
49. Cropmodelling, Organicgardening.
50. Vegetableproductionforpigments,exportandprocessing.
51. **Final examination**

COURSEOUTCOME

Aftersuccessfulcompletionofthiscourse,thestudentsareexposedto **CO 1**:
Advanced technology in vegetable production.
CO2:Prospectsandscopeofvegetableproduction.
CO 3: Modernconceptsin water&weedmanagement
CO4:Methodstocombatthenutritionaldisordersinvegetablecrops.
CO5:Lowcost- e f f e c t i v e techniquesforprotectedcultivationofvegetablecrops.

CO-POMappingmatrix

	PO1	PO2	PO3	PO4	PO5

CO1	**3**	**2**	**3**	**2**	**2**
CO2	**3**	**1**	**2**	**1**	**1**
CO3	**3**	**2**	**2**	**1**	**1**
CO4	**3**	**1**	**2**	**2**	**1**
CO5	**3**	**2**	**2**	**2**	**2**

References

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3. BrewsterJL.1994.OnionsandotherVegetableAlliums.CABI.
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E-Resources

1. https://www.agribunt.com/article-13.php
2. https://www.avrdc.org/index.php?id=143
3. https://www.freshplaza.com/news-detail.asp?id=29689
4. https://www.vigyanprasar.gov.in/comcom/develop62.htm
5. https://ucanr.org/freepubs/docs/8098

VSC-602ADVANCESINBREEDINGOFVEGETABLECROPS(3+0)

Learningobjectives

- Thestudentcan ableto understandgenetics andcytogenetics principlesappliedin cropbreeding techniques
- Thestudentcanapplytraditionalandmolecularbreedingmethodsfortheenhancementof vegetable crops.
- Interpretaboutgeneticdiversity,germplasmresourcesandconservation,
- Thestudentcanabletogainknowledgeregardinggovernmentpolicies,industryneedsand consumerpreferenceswhichcanaffectthevegetablecropimprovementprograms.
- Designandpresentavegetablebreedingresearchprojectthatmeetsspecificshort-termand long-term goals.

Theory

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollinationandfertilizationmechanisms,sterilityandincompatibility,anthesisandpollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance for the following crops

Unit-I:SolanaceousandMalvaceousvegetables

Tomato,brinjal,chilli,capsicumand okra

Unit-II:Cucurbitaceousvegetables

Allgourds,melons,perennialcucurbits

Unit-III:Fabaceous&Cruciferousvegetables

Peas,beans,cabbage,cauliflower,knolkholandturnip

Unit-IV:Root&tuberousvegetables

Carrot, radish,beetroot,tapioca,potato,sweetpotatoandelephantfootyam

Unit-V:Leafyandbulbousvegetables

Amaranthus,moringa,spinach,palak,lettuce,onionandgarlic

Lessonplan

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollinationandfertilizationmechanisms,sterilityandincompatibility,anthesisandpollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance in the following crops:

1.IntroductionaboutcropimprovementinSolanaceousandMalvaceousvegetables

2. Crop improvement in Tomato

3-4.CropimprovementinBrinjal

5-6. Crop improvement in Chilli

7-8. Crop improvement in Sweet Pepper

9-10. Crop improvement in Bhendi

11. IntroductionaboutcropimprovementinCucurbitaceousvegetables

12-13. Crop improvement in Ash gourd

14-15.CropimprovementinRidgegourd

16-17.CropimprovementinSnakegourd

18-19.CropimprovementinWatermelon

20-22.CropimprovementinMuskmelon

23. CropimprovementinPerennialCucurbitaceousvegetables–Pointedgourd

24. CropimprovementinPerennialCucurbitaceousvegetables–Ivygourd

25. FirstTest

26. CropimprovementinPerennialCucurbitaceousvegetables–Chow-Chow

27. IntroductionaboutcropimprovementinFabaceousandCruciferous vegetables

28. CropimprovementinPeas

29. Cropimprovementin Beans

30. Cropimprovementin Cabbage

31. Cropimprovementin Cauliflower

32. CropimprovementinKnol-Khol

33.Cropimprovementin Turnip

34.Cropimprovementin Carrot

35.Cropimprovementin Radish

36. Crop improvement in Beet root

37-38. Crop improvement in Tapioca

39-40.CropimprovementinSweetPotato

41. CropimprovementinElephantfootyam

42-43. Crop improvement in Potato

44. Cropimprovementin Amaranthus

45. Cropimprovementin Spinach

46. Cropimprovementin Palak

47. Crop improvement in Lettuce

48-49.CropimprovementinOnion

50.CropimprovementinGarlic

51. **Final examination**

COURSEOUTCOME

Thescholarwillbeableto

CO1:Understandthepollinationbehaviorandfertilizationmechanismsofvegetables.

CO2:Understandthescreeningtechniquesforimprovingvegetables.

CO3:Know howtodesignbreedingexperiments

CO4: Understandhybridizationtechniquesofvegetables

CO5:Gainknowledgeregardinggovernmentpolicies

	PO1	PO2	PO3	PO4	PO5

CO1	**3**	**2**	**2**	**2**	**2**
CO2	**3**	**2**	**3**	**3**	**1**
CO3	**3**	**2**	**2**	**3**	**1**
CO4	**3**	**2**	**1**	**3**	**2**
CO5	**1**	**1**	**1**	**1**	**1**

CO-POMappingmatrix

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E-Resource

1. www.dbtindia.nic.in
2. www.nre.vic.gov.au
3. www.agritech.tnau.ac.in
4. https://www.iihr.res.in
5. https://www.plantbreeding.org

VSC603ABIOTICSTRESSMANAGEMENTINVEGETABLECROPS(2+1)

Learningobjective

- Toupdateknowledgeontherecentresearchtrendsinthefieldofabioticstress management in vegetable crops.
- Toupdateknowledgeontherecentresearchtrendsinthefieldofbioticstress management in vegetable crops.
- Toupdateknowledgeregardingvegetableproductionunderstress
- To gainknowledge aboutvarioustypes ofenvironmentalstresses and their impacton vegetable production
- Toteachmanagementpracticestomitigateabioticandbioticstressesinvegetable production.

Theory

Unit-I:Stress,typesand classification

Environmental stress and its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress; root stock, use of wild species, use of anti-transpirants.

Unit–II:Mechanismsofstressinvegetablecrops

Mechanism and measurements of tolerance to drought, water logging, soil salinity, frostand heat stress in vegetable crops.

Unit–III:Environmentalfactorsrelatedtostress

Soil-plant-waterrelationsunderdifferentstressconditionsinvegetablecrops production and their management practices.

Unit-IV:Production techniquesofvegetables-I

Techniques of vegetable growing under water deficit, water logging, salinity and sodicity.

Unit–V:Production techniquesofvegetables-II

Techniques of vegetable growing under high and low temperature conditions, use of chemicals in alleviation of different stresses.

Practical

Identificationofsusceptibilityandtolerancesymptomstovarioustypesofstressin vegetablecrops,measurementoftolerancetovariousstressesinvegetablecrops,shortterm experimentsongrowingvegetableunderwaterdeficit,water-logging,salinityandsodicity, high and low temperature conditions, and use of chemicals for alleviation of different stresses.

Lesson plan

1. Stress–definitionandclassification-Environmentalstressanditstypes
2. Nutrientstressandoxidativestress
3. Classificationofvegetablecropsbasedonsusceptibilityandtolerancetovarioustypesof stress
4. Influenceofrootstockinstressalleviation-useofwildspecies
5. Useofantitranspirantsinmanagementofstress
6. Drought - toxicity symptoms- mechanisms governing tolerance- physiological and biochemicalfactorswithstress-impactonvegetablecrops-approachesandadvancesin management of drought
7. Flooding - toxicity symptoms- mechanisms governing tolerance- physiological and biochemicalfactorswithstress-impactonvegetablecrops-approachesandadvancesin

management of flooding

8. Soil salinity- toxicity symptoms- mechanisms governing tolerance- physiological and biochemicalfactorswithstress-impactonvegetablecrops-approachesandadvancesin management of saline soil
9. Sodicity- toxicity symptoms- mechanisms governing tolerance- physiological and biochemicalfactorswithstress-impactonvegetablecrops-approachesandadvancesin management of sodic soil
10. Frost - toxicity symptoms- mechanisms governing tolerance- physiological and biochemicalfactorswithstress-impactonvegetablecrops-approachesandadvancesin management of frost
11. Heat stress- toxicity symptoms- mechanisms governing tolerance- physiological and biochemicalfactorswithstress-impactonvegetablecrops-approachesandadvancesin management of heat stress
12. Temperature and Radiation stress-- toxicity symptoms- mechanisms governing tolerance-physiologicalandbiochemicalfactorswithstress-impactonvegetablecrops- approaches and advances in management
13. Nutrient stress and oxidative stress - toxicity symptoms- mechanisms governing tolerance-physiologicalandbiochemicalfactorswithstress-impactonvegetablecrops- approaches and advances in management
14. Soil-plant-water relations under drought condition in vegetable crops production and their management practices.
15. Soil-plant-water relations under flooded condition in vegetable crops production and their management practices.
16. Soil-plant-water relations under in vegetable crops production and their management practices.
17. **FirstTest**
18. Soil-plant-waterrelationsundersodicconditioninvegetablecropsproductionandtheir management practices.
19. Soil-plant-water relations under frost condition in vegetable crops production and their management practices.
20. Soil-plant-waterrelationsunderheatstressconditioninvegetablecropsproductionand their management practices
21. Techniquesofvegetablegrowingunderwaterdeficitcondition
22. Techniquesofvegetablegrowingunderwaterloggedcondition
23. Techniquesofvegetablegrowingundersalinesoil
24. Techniquesofvegetablegrowingundersodicsoil
25. Techniquesofvegetablegrowingunderfrostcondition
26. Techniquesofvegetablegrowingunderheatstresscondition
27. Techniquesofvegetablegrowingunderhighandlowtemperatureconditions,
28. Useofchemicalsinalleviationofdroughtcondition
29. Useofchemicalsinalleviationoffloodedcondition
30. Useofchemicalsinalleviationofsalinecondition
31. Useofchemicalsinalleviationofsodiccondition
32. Useofchemicalsinalleviationoffrostcondition
33. Useofchemicalsinalleviationofheatstress and drought condition
34. **Final examination**

Practical

1. Identificationofsusceptibilityandtolerancesymptomstodroughtinvegetablecrops
2. Identificationofsusceptibilityandtolerancesymptomstofloodinginvegetablecrops
3. Identificationofsusceptibility andtolerancesymptomstosalinity invegetablecrops
4. Identificationofsusceptibilityandtolerancesymptomstosodicityinvegetablecrops
5. Identificationofsusceptibilityandtolerancesymptomstofrostconditioninvegetable crops
6. Identificationofsusceptibilityandtolerancesymptomstoheatstressinvegetablecrops
7. Identificationofsusceptibilityandtolerancesymptomstonutrientstressinvegetable crops
8. Measurementoftolerancetodroughtinvegetablecrops
9. Measurementoftolerancetofloodinginvegetablecrops
10. Measurementof toleranceto salinityinvegetablecrops
11. Measurement oftoleranceto sodicityinvegetablecrops
12. Measurementoftolerancetofrostconditioninvegetable crops
13. Measurementoftolerancetoheatstressinvegetablecrops
14. Shorttermexperimentsongrowingvegetablesunderwaterdeficit
15. Shorttermexperimentsongrowingvegetablesundersalinityandsodicity
16. Useofchemicalsforalleviationofdifferentstresses
17. Useofchemicalsforalleviationofdifferentstresses

Courseoutcome

CO1-Acquiretheknowledgeabouteffectofdifferentabioticstressonproductionof vegetables.
CO2-Toupdateknowledgeonrecentresearchtrendsinthefieldofenvironmentalstress management in vegetables.
CO3-Gainunderstandingabouttechniqueofvegetablegrowingunderhighstresscondition.
CO4-Togainknowledgeonuseofchemicalsandanti-transpirantstoalleviatedifferenttypeof abiotic stresses.
CO5-Togainskillonthemanagementpracticestomitigateabioticstressinvegetablecrops.

CO–POMappingmatrix

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

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VSC - 604 SEED CERTIFICATION PROCESSING AND STORAGE OF VEGETABLE CROPS (2+1)

Learningobjective

- Toeducatetherecenttrendsintheseedprocessingofvegetablecrops.

- Toeducatetherecenttrendsintheseedstorageofvegetablecrops.
- Toeducatetherecenttrendsintheseedcertificationofvegetablecrops.
- Toeducatetherecenttrendsinthemarketingofseedsofvegetablecrops.
- Toknowaboutpolicyandseedactrelatedtoseedproduction

Theory

Unit-I:SeedcertificationandStandards

Seed certification- objectives - organization of seed certification - minimum seed certificationstandardsofvegetablecrops-fieldinspection-specificationforcertification.

Unit–II:Seedprocessingequipments

Seed processing - study of seed processing equipments - seed cleaning and upgrading - Seed packing and handling - equipmentused for packaging of seeds - procedures for allocating lot number. principles and procedures of field inspection,seed sampling,testing and granting certification

Unit -III: Factorsgoverningseed storage

Pre-conditioning - seed treatment – benefits - types and products - general principlesofseed storage-advances in methods of storage (open,bulk,controlled,germplasm,cryopreservation) - quality control in storage - storage containers - seed longevity and deterioration – sanitation - temperature and relative humidity control.

Unit–IV:Seedtesting

Seed testing; ISTA rules for testing – moisture - purity germination - vigor test - seed sampling - determination of genuineness of varieties - seed viability - seed health testing; seed dormancyandtypesofdormancy-factorsresponsiblefordormancy.

Unit-V:SeedMarketing

Seed marketing - demand forecast - marketing organization - economics of seed production; farmers' rights - seed law enforcement - seed act and seed policy.

Practical

Seed sampling, purity, moisture testing, seed viability, seed vigor tests, seed health testing, seed cleaning, grading and packaging; handling of seed equipment and processing machines; seed treatment methods, seed priming and pelleting; field and seed inspection, practices in rouging, seed storage, isolation distances, biochemical tests, visit to seed testing laboratories and processing plants, mixing and dividing instruments, visit to seed processing unit and warehouse visit and know about sanitation standards.

Lesson plan

1. Seedcertificationobjectives
2. Organization of seedcertification
3. Minimum seedcertificationstandardsofvegetablecrops
4. Fieldinspection
5. Specificationforcertification
6. Seedprocessing
7. Studyofseedprocessingequipments
8. Seedcleaningandupgrading

9. Seedpackingandhandling
10. Equipmentusedforpackagingof seeds
11. Proceduresforallocatinglotnumber
12. Pre-conditioningofseeds
13. Seedtreatment,benefits,typesandproducts
14. Generalprinciplesofseedstorage
15. Advancesinmethodsof storage
16. Quality control instorage
17. **FirstTest**
18. Storagecontainers,seedlongevityanddeterioration
19. Seedsanitation
20. Roleoftemperatureandrelativehumiditycontrolinseedstorage
21. Seedtesting:ISTArulesfortesting
22. Moisture,purity,germination,vigortest
23. Seedsampling
24. Determinationofgenuinenessofvarieties
25. Seedviability
26. Seedhealthtesting
27. Seeddormancyandtypesofdormancy
28. Factorsresponsiblefordormancy
29. Seedmarketing:demandforecast
30. Marketing organization
31. Economicsofseedproduction
32. Farmers'rights:PPVFRA
33. Seedlawenforcement and Seedactandseedpolicy
34. **Final examination**

Practical

1. Seedsamplingandanalysisofseedforphysicalandgeneticpurity
2. Moisturetesting
3. Seedviability
4. Seed vigor tests
5. Seedhealthtesting
6. Seedcleaning,grading and packaging
7. Handlingofseedtestingequipmentandprocessingmachines,mixinganddividing instruments
8. Seedtreatmentmethods,seedprimingandpelleting
9. Fieldandseedinspection
10. Practicesinrouging
11. Seedstorage
12. Isolationdistance
13. Biochemicaltests
14. Visittoseedtestinglaboratoriesandprocessingplants
15. Visittoseedprocessingunitandwarehouse
16. Standardsoffieldsanitation
17. Standardsoffieldsanitation

Courseoutcome

CO1-Thestudentswillacquireknowledgeonseedcertification.

CO2-Thestudentswillgetexposedtoprinciplesandprocedureoffieldinspection.
CO3-Thestudentswillunderstandtheprinciplesofseedprocessing.
CO4-Willgaincomprehensiveknowledgeonseed storage.
CO5-Thestudentswillgetequippedtoovercometheproblemsduetoseedaging,seed deterioration, loss of vigour& viability.

CO–POMappingmatrix

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

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VSC–605BREEDINGFORSPECIALTRAITSINVEGETABLECROPS
(2+1)

Learningobjective

- Thepresentcourseenablesthestudentstounderstandtheconsumptionlevelsofvegetables.

- Tounderstandthebasicsandprinciplesofbreedingprogrammesinvegetables.
- Toimpartknowledgeonbioactivepropertiesofvegetables.
- Toidentifythemethodsthatcontributestowardsloweringtheriskofcardiovasculardiseases.
- This course also helps to know the breeding programmes and scientific studies on bioactivecompounds of vegetables.

Theory

Important nutrient constituents in vegetables and their role in human diet. Genetics of nutrients. Genetic and genomic resources for improving quality traits in vegetables, breeding strategiesfordevelopingvarietieswithimprovednutritionformarketandindustrialpurposes.
Molecular and biotechnological approaches in breeding suitable cultivars of different crops for micronutrients and colour content.

Unit–I:

Brassicagroup,CarrotandBeetroot

Unit-II:

Tomato,Brinjal,PeppersandPotato

Unit–III:

Greenleafyvegetables,LegumecropsandOkra

Unit-IV:

CucurbitaceousvegetablecropsandEdibleAlliums

Unit-V:

Biofortificationinvegetablecrops,geneticengineeringforimprovementofqualitytraits in vegetable crops, bioavailability of dietary nutrients from improved vegetable crops, bioavailabilityofdietarynutrientsfromimprovedvegetablecropsandimpactonmicronutrient malnutrition, achievements and future prospects in breedingfor quality traits in vegetables.

Lessonplan

Importantnutrientconstituentsinvegetablesandtheirroleinhumandiet.Geneticsof nutrients. Genetic and genomic resources for improving quality traits in vegetables, breeding strategiesfordevelopingvarietieswithimprovednutritionformarketandindustrialpurposes.
Molecular and biotechnological approaches in breeding suitable cultivars of different crops for micronutrients and colour content.

1. CropimprovementforspecialtraitsinCabbage
2. CropimprovementforspecialtraitsinCauliflower
3. CropimprovementforspecialtraitsinBrusselssprout
4. CropimprovementforspecialtraitsinSproutingBroccoli
5. CropimprovementforspecialtraitsinKale
6. CropimprovementforspecialtraitsinKohlrabi
7. CropimprovementforspecialtraitsinCarrot
8. CropimprovementforspecialtraitsinRadish
9. CropimprovementforspecialtraitsinBeetroot
10-12. CropimprovementforspecialtraitsinTomato
13. CropimprovementforspecialtraitsinBrinjal
14. CropimprovementforspecialtraitsinChilli
15. CropimprovementforspecialtraitsinSweetpepper
16. CropimprovementforspecialtraitsinPotato
17. **FirstTest**
18. CropimprovementforspecialtraitsinSpinach

19. CropimprovementforspecialtraitsinLettuce
20. CropimprovementforspecialtraitsinPalak
21. CropimprovementforspecialtraitsinDrumstick
22. Cropimprovementfor specialtraits inFrenchbeans, Gardenbeans and Broadbeans
23. CropimprovementforspecialtraitsinGardenpeas
24. CropimprovementforspecialtraitsinOkra
25. CropimprovementforspecialtraitsinMelons
26. CropimprovementforspecialtraitsinGourds
27. CropimprovementforspecialtraitsinOnion
28. CropimprovementforspecialtraitsinGarlic
29. Bio fortificationinvegetablecrops
30. Bioavailabilityofdietarynutrientsfromimprovedvegetablecropsandimpacton micronutrient malnutrition.
31. Achievementsandfutureprospectsinbreedingforqualitytraitsinvegetables
32. Geneticengineeringforimprovementforqualitytraitsinvegetablecrops
33. Cropsbioavailabilityofdietarynutrientsfromimprovedvegetablecrops
34. **Final examination**

Practicalschedule

1. IdentificationandcharacterizationofBrassicaspeciesforbreedingpurposes.
2. HybridizationtechniquesintheBrassicagroupforimprovingyieldandquality.
3. BreedingmethodsfordiseaseresistanceinCarrotandBeetroot.
4. BreedingstrategiesforpestanddiseaseresistanceinTomato.
5. Cross-breedingtechniquesinBrinjalforhigh-yieldandqualityimprovement.
6. Selectionandhybridizationforfruitqualitytraitsin Peppers.
7. Potatobreedingfortuberqualityanddiseaseresistance.
8. BreedingfornutritionalenhancementinGreenLeafyVegetables.
9. Hybridizationandselectionfordiseaseresistanceandyieldin Legumecrops.
10. Okra breeding for resistance to abiotic stressessuch as drought andsalinity.
11. Hybridizationtechniquesforimprovingfruitqualityin Cucurbitaceouscrops.
12. BreedingfordiseaseresistanceinCucurbitaceousvegetables.
13. Breedingtechniquesforenhancingbulbsizeandqualityin EdibleAlliums.
14. Biofortificationstrategiestoincreasemicronutrientcontentinvegetablecrops.
15. Geneticengineeringtechniquesforqualitytraitimprovement in vegetables.
16. Evaluationofbioavailabilityofdietarynutrientsinbiofortifiedcrops.
17. Casestudiesontheimpactandfutureprospectsofbreedingforqualitytraitsinvegetable crops.

Courseoutcome

CO1-Acquiretheknowledgeonbreedingprogrammesofvegetablecrops.
CO2-Understandtheknowledgeonrecentdevelopmentinbreedingforimprovednutritional quality in vegetable crops.
CO3-Studentsabletounderstandthebioactivepropertiesofvegetables.
CO4-Studentsabletounderstandthecontributionofbreedingofvegetablestowardshuman health.
CO5-Incorporatetheknowledgeonbreedingprogrammesandscientificstudiesonbioactive compounds of vegetables.

CO–POMappingmatrix

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

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VSC–606BIODIVERSITYANDCONSERVATIONOFVEGETABLECROPS(2+1)

Learningobjective

- To understand the goals, issues and current status of biodiversity and conservation of vegetablecrops.
- Togainknowledgeaboutcollection,maintenanceandcharacterizationofgermplasm.
- To impart comprehensive knowledge aboutgermplasm exchange quarantine and intellectualproperty rights germplasm exchange.
- ToknowaboutGISapplicationinhorticulturalmappingandspatialanalysisoffielddata.
- Togainknowledgeaboutdifferentstrategiestoconservethegermplasminthepresentcontext.

Theory

Unit-I: Importance ofbiodiversityand methodsof conservation

Biodiversityandconservation-issuesandgoals-centresoforiginofcultivated vegetables- primary and secondary centres of genetic diversity- present status of gene centres-exploration and collection of germplasm- conservation of genetic resources- *in situ* and *ex situ* germplasm conservation- problem of recalcitrancy- cold storage of seeds-tissue culture-cryopreservation-pollenandseedstorage-inventoryofgermplasm.

Unit–II:RoleofNationalInstitutesin conservationandplantquarantine

Introduction of germplasm- plant quarantine- role of national institutes in conservation-TBGRI-NBPGR-etc-intellectualpropertyrights-regulatoryhorticulture-plantvariety protection authority- maintenance of core group using traditional knowledge for plant conservation. IPRS, Breeders rights, Farmers rights, PPV and FR act. GIS and documentation of local bio diversity, geographical indications.

Unit–III:Biodiversityoftropicalvegetable crops

Biodiversity of major tropical vegetable crops- Tomato- Brinjal- Chilli- Okra-Amaranthus- Cluster bean- Vegetable Cowpea- Cucurbits- Melons- Moringa- Dolichos bean-Broad bean

Unit-IV:Biodiversityoftemperatevegetablecrops

Biodiversity of major- temperate vegetable crops- Cabbage- Cauliflower- Knol Khol-Turnip- Brussels sprout- Chinese cabbage- Carrot- Beet root- Radish

Unit-V:Biodiversityofunderexploitedminorvegetablecrops

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

Practical

Documentation of germplasm- maintenance of passport data and other records of accessions- field exploration trips- exercise on *ex situ* conservation- cold storage- pollen or seed storage- cryopreservation- visits to national gene bank and other centres of pgr activities- core sampling-germplasmcharacterizationusingmoleculartechniques.

Lessonplan

1. Biodiversity-introduction,principles,goalsandissuesinconservation
2. Geneticdiversity-occurrenceanddistribution
3. Exploration,collection,characterization,documentationandcataloguingofgermplasm

4. Presentstatusofnationalandinternationalgenebanks
5. Roleofnationalinstitutesinconservation–TBGRI,NPBGRetc.,
6. Germplasmexchange,materialtransferagreementandcurrentquarantineprotocols
7. Methodsfor*exsitu*conservationofgermplasmand*insitu*conservationofgermplasm
8. Useof GIS and documentationof localbiodiversity
9. GISapplicationinhorticulturalmapping
10. Impactofclimatechangeonbiodiversity
11. IPRS,Breedersright,Farmersrights,PPV,FRAct.
12. BenefitsofGI protection.
13. Intellectualpropertyrights,plantvarietyprotectionauthority
14. StatusofbiodiversityofTomato
15. StatusofbiodiversityofBrinjal
16. StatusofbiodiversityofChilli
17. **FirstTest**
18. StatusofbiodiversityofOkra
19. StatusofbiodiversityofAmaranthus
20. StatusofbiodiversityofClusterbean
21. Statusofbiodiversityof Vegetablecowpea

22-23. Status of bio diversity of Cucurbits 24-

25. Status of bio diversity of Melons
26. StatusofbiodiversityofMoringa
27. StatusofbiodiversityofDolichosbeanandBroadbean
28. StatusofbiodiversityofCabbageandcauliflower
29. StatusofbiodiversityofKnolkholand Turnip
30. StatusofbiodiversityofBrusselssproutandChinesecabbage
31. StatusofbiodiversityofCarrot,BeetrootandRadish
32. Underexploitedminor vegetablecrops-presentstatusandscope
33. Minorvegetables-origin,distribution-biodiversity,propagation,conservationand utilization.
34. **Final examination**

Practical

1. Fieldexplorationtrips-exerciseincollectionandcharacterization
2. Visittofieldgermplasmunitanddocumentationofgermplasm
3. Practicesinmaintenanceofpassportdata
4. Practicalstudyon*exsitu*conservationmethods
5. Practicalstudyon*insitu*conservationmethods
6. Methodsofseedstorageforshortandlongtermconservation
7. Methodsofconservationusingvegetativepropagules
8. *Invitro*conservationprotocols
9. Studyofspeciesdiversityinhorticulturalcroppingsystem
10. Visittoregionalconservationcentres
11. Visittotropicalandtemperatevegetablefarms
12. Characterizationoftomatogermplasm
13. Characterizationofbrinjalgermplasm
14. Characterizationofokragermplasm
15. Identificationofminorvegetablecropsandtheirdescription
16. Useofmoleculartoolsforcharacterizingspeciesdiversity
17. Estimatingextendofdiversitythroughcollectionandanalysisofdata

Courseoutcome

CO1-Thestudentwouldbeexpectedtolearnaboutthesignificanceofgermplasm.
CO2-Toappreciateaboutpresentstatusofgenecentre,germplasmavailabilityanddatabase of vegetable crops in India.
CO3-Togainunderstandingaboutgermplasmcharacterizationusingastandard DUStest protocol.
CO4-Toappreciatevarioustechniquesusedintheconservationofgermplasm.
CO5-ToacquireknowledgeaboutbenefitsofGIprotectionandGItaggedfruitvarietiesin India.

CO–POMappingmatrix

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

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VSC-607BIOTECHNOLOGICALAPPROACHESINVEGETABLECROPS(2+1)

Learningobjectives

- Toprovideaninsightintothebasicprinciplesofbiotechnology
- Toimpartknowledgeonvarioustechniquesofbiotechnologyandtheirapplications.
- Toimpartknowledgeongeneticengineeringtechniques
- To gain information regarding the molecular markers and their thrust inHorticultural biotechnology

Theory

Unit–I:Importance,historyandscopeof biotechnology

Importance and scope of biotechnology – in vegetable crop improvement. In vitro culture, micropropagation, anther culture, pollen culture, ovule culture, embryo culture, endosperm culture.

Unit–II:Techniquesof tissueculture-I

Somatic embryogenesis - somaclonal variation and synthetic seed production, protoplast isolation, culture, manipulation and fusion. Somatic hybrids and cybrids and their application in vegetable improvement programme.

Unit–III:Techniquesoftissueculture-II

Blotting techniques, DNA fingerprinting-Molecular markers/DNA based markers and role. RFLP, AFLP, RAPD, SSR, SNPs, DNA probes. QTL mapping. MAS and its application in vegetable crop improvement. Allelemining by TILLING and Eco-TILLING.

Unit–IV:GeneticEngineeringandMoleculartechniques

Plant genetic engineering - Scope and importance, Concepts of cisgenesis, intragenesis and transgenesis. Gene cloning, direct and indirect methods of gene transfer. Role of RNAi based gene silencing in vegetable crop improvement. Bio-safety issue, regulatory issues for commercial approval.

Unit–V:GeneticEngineeringandMolecularTechniques

Concepts and methods of next generation sequencing (NGS) – Genome sequencing, transcriptomics, proteomics, metabolomics, Genome editing (ZFN, TALENS and CRISPER) Crops: Solanaceous crops, Cole crops, Cucurbitaceous crops, Root vegetables, Garden pea, Onion, Potato and Leafy vegetables.

Practical

Tissueculturelaboratoryorganization–asepticmanipulation–culturemedia preparation – inoculation of explants for clonal propagation – shoot tip, meristem – callus initiationandmultiplication–sub-culturingtechniques–regenerationofplants–techniquesof anther and ovule culture – somaclonal variation – *in-vitro* mutation – selection for abiotic stresses – development of protocols for mass multiplication – project development for establishment of commercial tissue culture laboratory

Lessonplan

1. Biotechnologicalapproachesinvegetablecropimprovement
2. Anther,Pollen,Ovule&Embryoculture in vegetablecrops
3. Endosperm andmeristemculturein vegetable crops

4. Widehybridizationandembryorescuetechniquesinvegetablecrops
5. Somaticembryogenesisinvegetablecrops
6. Somaclonalvariationforvegetablecropimprovement
7. Micro-graftinginvegetablecrops
8. Protoplastisolation,cultureand fusioninvegetablecrops
9. Somatichybridsandtheirapplicationinvegetablecropimprovement
10. Biotechnologicalapproachesinvegetablecropimprovement
11. Isolationofsecondarymetabolitesin*invitro*cultureofvegetablecrops
12. Cryopreservationanditsapplicationinvegetablecrops
13. Syntheticseedproductioninvegetablecrops
14. ImportanceandapplicationofBlottingtechniques
15. ImportanceandapplicationofDNAfingerprinting
16. Importanceofmolecularmarkers
17. **FirstTest**
18. Application of DNAbasedmarkers invegetablecrops-I
19. Application of DNAbasedmarkers invegetablecrops-II
20. ImportanceofQTLmappinginvegetablecrop improvement
21. MASanditsapplicationin vegetablecropimprovement.
22. AlleleminingbyTILLINGandEco-TILLING.
23. Plantgeneticengineering-Scopeandimportance
24. Conceptsofcisgenesis,intragenesisandtransgenesis.
25. Applicationoftransgenicsindevelopmentofvarietiesforresistance
26. Applicationoftransgenicsindevelopmentofvarietiesforqualityimprovement
27. Genecloningtechniques
28. Applicationofgenomeeditinginvegetablecropimprovement
29. RoleofRNAibasedgenesilencinginvegetablecrop improvement.
30. Bio-safety,regulatoryissuesforcommercialapproval.
31. Conceptsandmethodsofnextgenerationsequencing(NGS)
32. Transcriptomicsinvegetablecropimprovement
33. Proteomics and Metabolomicsinvegetablecrops
34. **Final examination**

Practical

1. Introductiontomicropropagation
2. Invitroshootingandrooting
3. Pollenculturemethod
4. Ovuleculturemethod
5. Embryoculturemethod
6. Syntheticseedproduction
7. Inductionof*invitro*mutation
8. Hardeningofplantlets
9. IsolationofDNAfromeconomicallyimportantvegetablecropvarieties
10. QuantificationandamplificationofDNA
11. DNAprofiling
12. Proteinprofiling
13. Useofmolecularmarkersforcharacterization
14. Genetictransformationtechniques
15. Genomeeditingprocedures
16. Visit to commercialTC units
17. Projectpreparationforestablishmentoflow,mediumandhighcosttissueculture

laboratories

Courseoutcome

CO1-To understand aboutsomaticembryogenesisandtheirapplicationinvegetable crop improvement.
CO2-Thestudentwilllearndifferentbiotechnologicaltoolusedinthecropimprovement.
CO3- Toknow theroleofRNAibasedgenesilencingin vegetablecropimprovement.
CO4-Tolearnconceptsandadvancedmethodsoftissueculturetechnology.
CO5-Thestudentwouldbeexpectedtolearnbiotechnicaladvancementinvegetablecrops.

CO-POMappingmatrix

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

References

1. Brown, T.A 2001.Gene Cloning and DNA Analysis – An Introduction. Blackwell Publication.
2. Keshvachandran P.A. Zazeem, D.Girija, PS Jola &K.V.Petter 2007. Recent Trends in Biotechnology of Horticultural crops. New India Publication Agency, New Delhi
3. Parthsarathy,V.A.,Bose,T.K.,Deka,P.G,Das,P.,MitraS.K.andMohanadas,S.2001. BiotechnologyofHorticulturalCropsvol.I-III,NayaProkash.
4. Prasad,SandL.K.Pareek.2004.ImpactofBiotechnologyonHorticulture.Agrobios Publication, Bikaner.
5. Purohit,S.S.2004.PlantTissueCulture.Agrobios(India),Jodhpur.
6. Razdan, M.K. 1992. Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co (P) Ltd, New Delhi.
7. Singh,B.D.2001.Biotechnology.KalyaniPublications,NewDelhi.
8. GloverMD.1984.Genecloning,themechanicsofDNAmanipulation.ChapmanandHall.
9. GordenHandRubsellS.1960.Hormonesandcellculture.ABBookpubl.
10. SharmaR.2000.Planttissueculture.CampusBooks.

E-Resources

1. https://www.dbtindia.nic.in
2. https://www.nre.vic.gov.au
3. https://agritech.tnau.ac.in
4. https://www.mdpi.com
5. http://www.ijcmas.com

VSC–
608ADVANCEDLABORATORYTECHNIQUESFORVEGETABLECROPS(1+2)

Learningobjective

- Tofamiliarizewiththelaboratorytechniquesforanalysisofvegetablecrops.
- Tounderstandthesafetymeasuresandlaboratorymaintenance.
- Toknowthequalitativeandquantitativeanalysismethod.
- Togaintheknowledgeonbasicchromatographictechniques.
- Togaincomprehensiveknowledgeonsensoryanalysistechnique.

Theory

Unit-I:Safetymeasuresandlaboratorymaintenance

Safety aspects andupkeep of laboratory, sampling procedures for quantitative analysis, determination of proximate composition of horticultural produce. Standard solution, determination of relative water content (RWC), physiological loss in weight (PLW), calibration and standardization of instruments, textural properties of harvested produce, TSS, Specific gravity, pH and acidity.

Unit-II:Destructiveandnon-destructiveanalysismethods

Refractometry, spectrophotometry, non-destructive determination of colour, ascorbic acid, sugars and starch in food crops.

Unit-III:Chromatographicanalysis

Basic chromatographic techniques, GC, HPLC, GCMS, Electrophoresis techniques, ultra filtration. Application of nuclear techniques in harvested produce.

Unit-IV:Microscopicanalysis

Advancedmicroscopictechniques,ionleakageasanindexofmembranepermeability, determination of biochemical components in horticultural produce.

Unit-V:Sensoryanalysis

Importance of ethylene, quantitative estimation of rate of ethylene evolution, using gas chromatograph (GC). Sensory analysis techniques, control of test rooms, products and panel.

Practical

Accurate quality analysis of vegetables warrants stringent measurement protocols besides requisite instruments/ tools and laboratory facilities. Consequently, a specialized course for practicals is designed for imparting basic and applied training on physical and biochemical assessment of the vegetable produce.

Lesson plan

1. Safetymeasuresandlaboratorymaintenance
2. Samplingproceduresforquantitativeanalysis.
3. Determinationofproximatecompositionofhorticulturalproduce.
4. Standardsolutions,relativewatercontent(RWC)
5. Physiologicallossinweight(PLW)
6. Instruments,texturalpropertiesofharvestedproduce,TSS,Specificgravity,pHand acidity.
7. Destructiveanalysismethods–Refractometry,Spectrophotometry.

8. Non-destructiveanalysismethods.
9. **FirstTest**
10. Chromatographic analysis– GC,HPLC, GCMS
11. Electrophoresistechniques,ultrafiltration
12. Nucleartechniquesinharvestedproduce.
13. IntroductionAdvancedmicroscopictechniques
14. Membranepermeability,biochemicalcomponentsinhorticulturalproduce.
15. Sensoryanalysis-Importanceofethylene
16. Rateofethyleneevolution-usinggaschromatograph(GC) and Sensoryanalysistechniques
17. **Final examination**

Practical

1. Safetymeasuresinlabsandhandlingofchemicalsubstances.
2. Commonlaboratoryequipments.
3. Calibrationandcleanlinessofvolumetricglasswares.
4. Methodsofexpressingstrengthoffsolutions
5. Preparationofprimarystandardsolutionsandbuffersolutions
6. Preparationofstandardsolutionsfornutrientanalysisofsoil,plantandwater.
7. Preparationsofdifferentagro-chemicaldosesforfieldexperiments,preparationofbuffersolutions.
8. Handlingofinstruments
9. Determinationofmoisture
10. Determinationofrelativewatercontent
11. Determinationofphysiologicallossinweight
12. Calibrationandstandardizationofinstruments
13. Texturedpropertiesofharvestedproduce
14. DeterminationofTSS,PH,Acidity.
15. DeterminationofFibre
16. Determinationofprotein
17. DeterminationofStarchIndex(SI)
18. Determinationofspecificgravityformaturityassessment
19. Detectionofadulterationsinfreshproducts
20. Detectionofadulterationsinprocessedproducts
21. Introductionondestructiveandnon-destructiveanalysismethods
22. Non-destructivedeterminationofcolour
23. Non-destructivedeterminationofascorbicacid
24. Non-destructivedeterminationofvitamins
25. Non-destructivedeterminationofcarotenoids
26. Non-destructivedeterminationofsugarsandstarch
27. Introductiononchromatographicandmicroscopicanalysis
28. Studyofbasicchromatographictechniques
29. StudyofGC,HPLCandGCMS
30. StudyofElectrophoresistechniquesandUltrafiltration
31. Introductiononadvancedmicroscopes
32. Useofadvancedmicroscope–Fluorescentmicroscope
33. Useofadvancedmicroscope–Scanningelectronmicroscope
34. Useofadvancedmicroscope–phasecontrastmicroscope

Courseoutcome

CO1-Thestudentswouldbeexpectedtodevelopskillsandexpertiseonupkeepoflaboratories and

methods to operate research equipment's.
CO2-Tomakeawareonsafetymeasuretobetakenandupkeepoflaboratory.
CO3-Togainknowledgeonprinciplesandmethodsofdestructiveandnon-destructive analysis.
CO4-Togainskillonchromatographicandmicroscopicanalysis
CO5-Toacquireskillonhandlingofresearchinstruments.

CO–POMAPPING

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

References

1. AOACInternational.2003.OfficialmethodsofanalysisofAOACinternational.17thEd.Gaithersburg, MD, USA, associated of analytical communities, USA.
2. CliftonMandPomeranzY.1988.Foodanalysis–Laboratoryexperiments.AVIpublications,USA.
3. LinskensHFandJacksonJF.1995.Fruitanalysis.Springer.
4. LeoML.2004.Handbookoffood analysis,2ndEd.Vols.I-III, USA.
5. PomrenzYandMeloanCE.1996.Foodanalysis –theoryandpractice.CBS, USA.
6. RangannaS.2001.Handbookofanalysisandqualitycontrolforfruitandvegetableproducts.2nd Ed. Tat-McGraw-Hill, New Delhi.
7. ThompsonAK.1995,Postharvesttechnologyoffruitsandvegetables.Blackwellsciences.USA.

E-Resources

1. https://www.agr.shizuola,ac.jp
2. https://www.syngenta-us.com
3. https://videleaf.com
4. https://www.iihr.res.in
5. https://cbseacademic,nic.in

COM601ADVANCESINCOMPUTERAPPLICATIONS(1+1)

CourseObjective

- To acquaint the students with open source tool, Latex typesetting language, Python and its usage in the industry

Theory

UnitIIntroductiontoLatex:

Introduction to Latex – What is Latex – Document Structure, Start Text works, Title, Section, Table of content – Typesetting Text, Font Effects, Coloured Text, Font Size, List, Comments & Spacing, Special Charcters.

UnitIIPackagesandClassesinLatex:

Inserting Equations – Mathematical Symbols – Table of Content – Generating New Command – Figure handling numbering, List of figure, List of Tables. Packages – Geometry,Hyperref, amsmath, amssymbol – Classes – Article, Book, report - The BibTex file – Inserting Bibliography – Citing – References.

UnitIIIMSAccess:

MSACCESS: Database, concepts and types - Uses of DBMS in Agriculture; creating database.

UnitIVIntroductiontoPython:

Python Introduction, Technical Strength of Python, Introduction to Python Interpreter and program execution, Using Comments, Literals, Constants, Python's Built-in Data types, Numbers (Integers, Floats, Complex Numbers, Real, Sets), Strings (Slicing, Indexing, Concatenation,otheroperationsonStrings),AcceptinginputfromConsole,printingstatements , Simple 'Python' programs.

UnitVUsingDatabasesinPython:

Database Programming: Connecting to a database, Creating Tables, INSERT, UPDATE, DELETE and READ operations, Transaction Control, Disconnecting from a database.

LectureSchedule

1. IntroductiontoLatex.
2. Document Structure.
3. Classes.
4. TypesettingText.
5. InsertingEquations
6. PackagesandMathematicalSymbols.
7. List offigure.
8. List of Tables.
9. **FirstTest**
10. BibliographyandReferences.
11. MSAccessConceptsofDatabase,CreatingDatabase.
12. DBMSinAgriculture.
13. IntroductiontoPython.
14. Built-inDatatypes.

15. Strings.
16. PythonConsole.
17. DatabaseinPython.
18. **Final examination**

PracticalSchedule

1. InstallationofLatex
2. BasicLatexcommands
3. LatexCompilation,PageLayout
4. BuildingaLatexdocument,Previewingfirst.tex
5. Additionofsometextinthe.texfile,Findingtheerrorandfixingit
6. Typesettingofmathematics
7. Writingequations,matrix
8. Twofigurenexttoeachother,Formationoftable
9. Typesettingwithanewchapterheading,Listoffigures,Listoftables
10. Citation,Bibliography,printingyourdocument
11. MSACCESS:CreatingDatabase,preparingqueriesandreports
12. MSACCESS:DemonstrationofAgri-informationsystem
13. IntroductiontoPython,Workingwith Data
14. ProgramOrganization, Functions,andModules,ClassesandObjects
15. InsidethePythonObjectSystem
16. Testing,DebuggingPractice Packages
17. SoftwareDevelopment PracticePackages

CourseOutcome:

CO 1: Problem solving andprogrammingcapability
CO2: Analysecommon problemsusingLatex
CO3: Learncategoriesofprograms
CO4: ConstructandexecutebasicprogramsinPython
CO5: UseexternallibrariesandpackageswithPython

CO-POMappingMatrix

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

SuggestedReading

1. IntroductiontoLatexbyTobiasOetiker
2. LaTeX:ADocumentPreparationSystem,2ndEditionByLeslieLamport
3. CharlesDierbach,"IntroductiontoComputerScience usingPython", Wiley,2015
4. Python Programming- A modular Approach (with Graphics, database, Mobile and Web Applications by Sheetal Taneja and Naveen Kumar, Pearson.
5. HeadFirstPythonbyPaulBerry, O'Reilly

e-Resources

1. https://www.overleaf.com/learn/latex/Bibliography_management_with_bibtex
2. https://en.wikibooks.org/wiki/LaTeX/Bibliography_Management.
3. https://wiki.python.org/moin/PythonBooks.
4. https://devfreebooks.github.io/python/
5. https://www.digitalocean.com/community/books/digitalocean-ebook-how-to-code-in-python.

STA601ADVANCESINDESIGNOFEXPERIMENTS(2+1)

CourseObjective

- To acquaint the students to understand the concepts of statistical hypothesis, design of experiments, statistical methods, data collection, analysis and interpretation of results and to acquire Multivariate Statistical Analysis skills.

Theory

Unit–I:SamplingTechniques

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

Unit–II:StatisticalMethods

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

Unit–III:CorrelationandRegressionAnalysis

Correlation, Rank correlation, Correlation ratio, Intra-class correlation. Test of significance of correlation coefficient. Coefficient of determination.- Path analysis - Regression analysis, Partial and multiple correlation and regression. Estimation of parameters. Predicted valuesandresiduals.Introductiontomultivariateanalyticaltools.Testofhypothesisonmeans, Multivariate analysis of variance and covariance, Cluster analysis, Classification by linear discriminant function, Canonical correlations, Principal components, Factor analysis, multi-dimensional scaling and Correspondence Analysis. Hierarchical clustering. Principal component analysis.

Unit–IV:ExperimentalDesigns

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

Unit–V:FactorialExperiments

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

Practical

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

LectureSchedule

1. Classification,tabulationandgraphicalrepresentationofdata.
2. Descriptivestatistics.
3. Theoryofprobability.Randomvariableandmathematicalexpectation.
4. Box-plot.Probabilitydistributions:Binomial,Poisson,Negativebinomial.
5. Normaldistributionsandtheirapplications.
6. Conceptofsamplingdistribution:t,chi-squareandFdistributions.
7. Testsofsignificancebasedonnormal,t,chi-squareandFdistributions.
8. Correlation,Rankcorrelation,Correlationratio.
9. Intra-classcorrelation.Testofsignificanceofcorrelationcoefficient.
10. Coefficientofdetermination.
11. Pathanalysis.
12. Regressionanalysis.
13. Partialandmultiplecorrelationandregression.
14. Estimationofparameters.Predicted valuesandresiduals.
15. Introductiontomultivariateanalyticaltools.
16. Testofhypothesisonmeans,Multivariateanalysisofvarianceandcovariance.
17. **FirstTest**
18. Clusteranalysis,Classificationbylineardiscriminantfunction.
19. Canonicalcorrelations,Principalcomponents.
20. Factoranalysis,multi-dimensionalscalingandCorrespondenceAnalysis.
21. Hierarchicalclustering.
22. Principalcomponentanalysis.
23. Needfordesignofexperiments,characteristicsofagooddesign.

24. Basicprinciplesofdesigns-randomization,replicationandlocalcontrol.
25. Uniformitytrials,sizeandshapeofplotsandblocks;Analysisofvarianceand covariance; partitioning of degrees of freedom.
26. Completelyrandomizeddesign,randomizedblockdesignandLatinsquaredesign.
27. Factorialexperiments:Layoutandanalysisof factorialexperiments.
28. Completeblockdesign–split–plotdesign.
29. Strip-plotdesign:split–plotdesign.
30. Resolvableblockdesigns andtheirapplications.
31. Randomizationprocedure, analysis and interpretationofresults.
32. Analysisofcovariance.Missingplottechniqueanditsapplicationto RBD,LSD, Factorialexperiments(symmetricalaswellasasymmetrical).
33. Factorialexperimentswithcontroltreatment.Groupsofexperiments.Transformation of data.
34. **Final examination**

Practicalschedule

1. Exploratorydataanalysis,Box-Coxplots;Fittingofdistributions~Binomial,Poisson, NegativeBinomial,Normal;Largesampletests.
2. Testingofhypothesisbasedonexactsamplingdistributions~chisquare,tandF.Confidence interval.
3. EstimationandpointestimationofparametersofBinomial,PoissonandNormal distribution.
4. Correlationandregressionanalysis.
5. Fittingoforthogonalpolynomialregression.
6. ApplicationsofdimensionalityreductionandDiscriminantfunctionanalysis.Non-parametric tests.
7. AnalysisofdataobtainedfromCRD,RBD,LSD.
8. AnalysisofCovariance.
9. Analysisoffactorialexperimentswithoutandwithconfounding,Analysiswith missing data.
10. Splitplotandstripplotdesigns.Groupsofexperiments,Transformationofdata.
11. ExercisesonvariousNon-parametrictests.
12. Randomsampling,Useofrandomnumbertables,Simplerandomsampling,Determination of sample size.
13. ExercisesonInversesampling,Stratifiedsampling.
14. ClustersamplingandSystematicsampling.
15. EstimationusingRatioandregressionestimators.
16. EstimationusingMultistagedesign andDouble sampling.
17. PracticalExamination.

CourseOutcome

CO1: Gainingknowledgeonbasicandrecentconceptsofstatisticalmethods
CO 2: Proficiency in data Collection, analysis and interpretation of results
CO 3: Understanding the testing of statistical hypothesis
CO4: Knowledgeonmultivariatestatisticalanalysis
CO5: Designofexperimentsinagriculturalfieldanddataforanalysis

CO–POMappingMatrix

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	1
CO2	3	3	2	1	2
CO3	3	3	2	1	2
CO4	3	3	1	1	3
CO5	3	3	1	1	2

SuggestedReading

1. Agarwal,B.L.2003,BasicStatistics,NewAgeInternational.New Delhi.
2. Anderson,T.W.1958.*AnIntroductiontoMultivariateStatisticalAnalysis.*JohnWi ley, New Delhi.
3. Bansil,P.C.2002.*Agrl.Statistics*.CBSPublishers.NewDelhi.
4. Box,G.E.P.,Jenkins,G.M.andReinsel,G.C.1994.*TimeSeriesAnalysis:Forecasti ng and Control*. Pearson Education, Delhi.
5. Campbell,R.A.1974.*StatisticsforBiologists.*CambridgeUniversityPress.NewYork.
6. Cochran,W.G.and Cox, G.M. 1957.*Experimental Design.*JohnWiley and Sons Inc. New York.
7. Das,M.N.andGiri,N.C.1986.*DesignandAnalysisofExperiments.*NewAge International. New Delhi
8. Federer,W.T.2002.*StatisticalDesignandAnalysisofIntercroppingExperiments.* Springer-Verlag.NewYork
9. GomezandGomez.1984.*StatisticalprocedureforAgrl.Research.*Wiley-interscience. New York
10. Gupta,S.P.2004,StatisticalMethods,S.ChandandSons.NewDelhi.SinghRand Mangat N.S. 1996. *Elements of Survey Sampling*. Kluwer Academic Publishers.

NGC611-RESEARCHANDPUBLICATIONETHICS(2+0)

LearningObjectives:

- Toimpartknowledgeonresearchethics,academicconductandIntegrity.
- Tosensitizethescholarsabouttheirresponsibilitiestoscience,societyandeco-system.
- Toequipthescholarswithtechniquesandskillstoavoidethicalmisconduct.
- Toprovidehandsonexperienceintheusevarioussoftwaretoolsinresearchand publication process.
- Toacquaintparticipantswithtoolsandtechniquespopularlyutilizedforensuring academic standards, avoiding plagiarism, and promoting high impact publication.

Theory

Unit-1:Philosophy,Ethics&ScientificConduct

Introductiontophilosophy:definition,natureandscope,concept,branches-Ethics**:** definition,moralphilosophy,natureofmoraljudgmentsandreactions-Ethicswithrespectto scienceandresearch-Intellectualhonestyandresearchintegrity-Scientificmisconducts**:** Falsification,Fabrication,andPlagiarism(FFP)-RedundantPublications**:**duplicateandoverlappingpublications,salamislicing-Selectivereportingandmisrepresentationofdata

Unit- 2: Publication Ethics

Publication ethics: definition, introduction and importance - Best practices/ standard setting initiatives and guidelines: COPE, WAME, etc. - Conflict of Interest - Publication misconduct:definition,concept,problemsthatleadtounethicalbehaviorandviceversa,types-Violation of publication ethics, complaints and appeals - Identification of publication misconduct, complaints and appeals - Predatory publication and journals

Unit-3:OpenAccessPublishing

Open access publication and initiatives - SHERPA/RoMEO Online resource to check publisher copyright & self-archiving policies - Software tool to identify predatory publications developedbySPPU-Journalfinder/journalsuggestiontoolviz.JANE,ElsevierJournal Finder, Springer Journal Suggestion, etc.

Unit-4:Publication Misconduct

GroupDiscussions- Subjectspecificethicalissues,FFP,authorship-Conflictsofinterest-Complaints and appeals: examples and fraud from India and abroad - Software tools - Use of plagiarism software like Turnitin, Urkund and other open-source software tools.

Unit-5:DatabasesandResearchMetrics

Databases - Indexing databases - Citation databases: Web of Science, Scopus, etc., - Research Metrics (Journal) - Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score - Research Metrics (Author) - Metrics: h- Index, i10 index, altimetric.

Lectureschedule

1. Introductiontothephilosophy:definition,natureandscope,
2. Concept,branchesofPhilosophy
3. Ethics:definition,moralphilosophy,rationalandnon-rationalapproachestoethical issues
4. Natureofmoraljudgmentsand reactions
5. ResearchProcess-ResearchethicsandGuidingprinciples-ResearchEthicsCommittee-Animal Ethics Committee-Approval
6. Intellectualhonestyandresearchintegrity
7. Scientificmisconducts:Falsification,FabricationandPlagiarism(FFP)-
8. Factorsfacilitatingscientificmisconducts
9. EthicsandTrust:Anonymity,Confidentiality,Conflictsofinterest/role/values/ ownership and Competing interest
10. Literaturesearch-Print,Online,keywords-booleansearch-Inflibnet-E-databases
11. Fundamentalsofmanuscriptpreparation
12. Technicalwritingskills
13. Publicationethics:definition,introductionandimportance
14. Best practices/ standardsettinginitiatives andguidelines: COPE, WAME,etc
15. Publicationmisconduct:definition,Authorship-Redundantpublications:
16. Duplicateandoverlappingpublication,Salamislicing
17. **Firsttest**
18. Selectivereportingandmisrepresentationofdata
19. Violationofpublicationethics,authorshipandcontributorship
20. Identificationofpublicationmisconduct,complaintsandappeals:examplesandfraud from India and abroad-
21. UGCandUniversityguidelinesandPunishment
22. Software tools - Use of Reference Management Tools to avoid plagiarism and automation of bibiliography
23. Softwaretools-UseofplagiarismsoftwarelikeTurnitin,andUrkund
24. Otheropensourcesoftwaretools
25. Howtopublishinscholarlyjournals?-Openaccesspublicationandinitiatives-
26. UGC-CAREList-Predatorypublicationjournals
27. Databases-Indexingdatabases
28. Citationdatabases:WebofScience,Scopus,etc
29. JournalMetrics-(c)ImpactFactorofjournalasperJournalCitationReport,SNIP,SJR, IPP, Cite Score
30. SHERPA/RoMEOOnlineresourcetocheckpublishercopyright&self-archiving policies
31. SoftwaretooltoidentifypredatorypublicationsdevelopedbySPPU

32. Journalfinder/journalsuggestiontoolviz.JANE,ElsevierJournalFinder,Springer Journal Suggestion, etc.
33. Howtosharethepublicationsandknowtheimpact? And AuthorMetrics:AuthorID-OrcidID-h-Index,i10index,altmetrics
34. **Final examination**

CourseOutcomes:

CO1: Willbeabletoidentifytheethicalissuesinresearchprocessbasedontheconceptof philosophy and ethics.

CO2: Willbeabletoavoidscientificmisconductlikefabrication,falsificationandfraudin the research process by following the recommended guidelines.

CO3: WillbeabletousetoolslikeReferenceManagement,JournalIdentification,Open Access, Plagiarism Checker and avoid misconduct.

CO4: Willbeabletocommunicatetheresearchfindingsinapprovedjournalswithhigh journal metrics and also improve the author metrics.

SuggestedReading

1. Barbara H. Stanley, Joan E. Sieber and Gary B. Melton.1996. Research Ethics: A Psychological Approach. University of Nebraska Press
2. Jeffrey A. Gliner, George A. Morgan and Nancy L. Leech.2009. Research Methods in Applied Settings: An Integrated Approach to Design and Analysis. Routledge; 2nd edition
3. Joel Lefkowitz. 2017. Ethics and Values in Industrial-Organizational Psychology. Routledge
4. Sidney Hook, Paul Kurtz, and Miro Todorovich.1977. The Ethics of Teaching and Scientific Research. Prometheus Books