FACULTY OF AGRICULTURAL SCIENCES

ORDINANCE

M.Sc. Agriculture

(2020-21)

SHREE GURU GOBIND SINGH TRICENTENARY UNIVERSITY
GURUGRAM (DELHI-NCR)

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COURSE ORDINANCE

1. PREAMBLE

The higher education system in the country has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and equality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and equality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvements in the higher educational system.

Faculty of Agricultural Sciences, Shree Guru Gobind Singh Tricentenary University, Gurugram with the aim to enhance academic standards in quality of higher education has adopted the UGC/ICAR guidelines for all PG courses.

The grading system is considered to be better than the conventional marks system and in order to facilitate students' mobility across institutions within India and across countries the cumulative grade point average (CGPA) has been introduced in the PG courses.

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional percentage system. Therefore, it is imperative to introduce uniform grading system in the entire higher educational in India. This will benefit the students to move across institutions within India and across countries as well. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Commulative Grade Point Average (CGPA) based on student's performance in examination, the UGC/ICAR has formulated the guidelines to be followed.

Outline of choice Based Credit System:

a. Core/Major Courses: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core Course.

b. Minor subject: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provide and extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency.

c. Advisory Committee: Minimum three members (two from major subject including chairman and one from minor subject) to be constituted within 12 weeks of first semester.

d. Synopsis: A brief outline of proposed project should be accomplished in the first semester by a student in consultation with advisory committee. Student will present the same before advisory committee for suggestion and submitted to Dean FASC for approval.

e. Thesis: A research project is assigned to PG scholar as per his/her interest with a support of advisory committee consisting of faculty members is called thesis.

f. Supporting subject: The subject is not related to major subject. It could be any subject considered relevant for student research work or necessary for building his/her overall competence.

g. Skill Enhancement Course: These six non credit compulsory courses are of general nature and are compulsory for Masters programme.

h. Comprehensive Exam: It is non credit written examination to assess the overall comprehension of the student after he/she completes 75% course work separately in major and minor subjects.

i. Thesis Submission: Thesis seminar should be presented before the advisory committee at least one month before final submission of the thesis.

j. Evaluation and Viva-Voce: Panel of external examiners comprising three, proposed by chairman in consultation with Head shall be submitted to Dean (FASC) for selection and approval.

2. GOALS:

i. Employment prospects for post graduates students in agriculture are very good. The scientific knowledge enhances prospects of job in research and development in govt. and private sectors.
ii. The course will build a rich knowledge base to provide a foundation for the continued study of science.
iii. The theoretical and experimental skills necessary to analyze and solve a range of problems, providing an excellent foundation skill leadership.
iv. Post-graduation leads to abundance of research opportunities.

3. OBJECTIVES:

The postgraduate training should enable the student to:

i. Evaluate and compare different technologies for sustainable agriculture production systems.
ii. Identify various cropping sequences based upon the market forces impacting demand and supply of different commodities.
iii. Compare existing farming systems with natural organic farming system vis-à-vis sustainability of productivity as well as ecosystem.
iv. Visualize and evaluate different entrepreneurial skills for developing farming into a lucrative profession.
v. Upgrade the agricultural produce into value added products for developing agriculture into a remunerative business.
vi. Translate the innovative agro-technologies farmer friendly for improving their lot.
vii. Adopt agri-business as an entrepreneur for attracting the young minds into agricultural profession.
viii. Improve agriculture productivity, manage products and pave way for future developments through research activities.

4. Duration and Nomenclature of the course:

The Duration of M.Sc. Agriculture course shall be of two academic years consisting of four (4) semesters (15-17 weeks each semester) under Credit Based System (CBS). On successful completion of all four semesters, the students will be awarded M.Sc. degree. The student shall complete the course within a maximum period of four (4) years from the date of admission to the first semester.

5. Eligibility for admission:

For admission to M.Sc. Agriculture course, the candidate must have passed B.Sc. Agriculture/B.Sc. (Hons.) Agriculture with at least 55% marks (50% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any recognized university.

S.No	Criteria	Condition
1	On the basis of the merit of the qualifying Examination.	If the number of applicants is up to 3 times of the intake.
2	On the basis of the merit of the Entrance Examination.	If the number of applicants is more than 3 times of the intake.

6. Syllabus:

The syllabus recommended by Indian Council of Agricultural Research (ICAR) has been adopted. It is based on Choice Based Credit System (CBCS) and is recommended by Board of Studies and approved by Academic Council from time to time.

7. Scheme of Examination, distribution of marks and credit system:

The scheme of examination, distribution of marks in various papers and the credit system of the course shall be as approved by Board of Studies/Academic Council from time to time.

8. Medium of Instructions and Examination:

The medium of the instructions and the examinations shall be English.

9. Attendance Requirements/Eligibility to Appear in Examination:

The student should fulfill the following criteria to be eligible for appearing in the End Term Semester Examinations:

i. He/she should bear a good moral character.
ii. He/she should be on the rolls of the Dept./Faculty of the University during the semester.
iii. He/she should have 75% of the attendance during the respective semester.
iv. The Dean of the Faculty on his own or on the recommendation of the HOD shall have the power to give relaxation up to 5% on genuine grounds over the minimum requirement of 75% attendance.
v. Further, the Vice Chancellor on his own or on the recommendation of the Dean shall have the power to give further relaxation up to 5% on genuine grounds over the above mentioned attendance.
vi. He/she should not be a defaulter in payment of any dues of the SGT University and no disciplinary action is pending against the student.

10. Exemption of Attendance / Shortage of attendance to be condoned:

The Shortage of lecture maximum limit as under can be condoned by the competent authority.

S. No.	Exemptible No. of Lectures	Ground of Exemption	Competent Authority
1.	All periods of the days of blood donation	Voluntarily blood donation to the Blood Bank	Dean of the Faculty
2.	All Periods of the day of Examination	For appearing in the supplementary examinations (Theory/Practical/Viva-voce)	-do-
3.	10 days attendance during a semester	For participation in university or Inter-Collegiate sports Tournaments/youth Festivals, NCC/ NSS Campus/ University Educational Excursions/ Mountaineering Courses.	-do-
4	15 days attendance during a semester	For participation in Inter- University Sports Tournaments Youth Festivals.	-do-

Provided:

i. That he/she obtained prior approval of the Dean, Faculty of Agricultural Sciences.
ii. That credit may be given only for the days on which lectures were delivered or tutorials or practical work was done during the period of participation in the aforementioned events.

11. Attendance Shortage Warning:

Attendance shortage warning will be displayed on the Faculty's Notice Board and University Website by 10th day of every month.

12. Detained students:

A student who does not fulfill the criteria prescribed in clauses 9-10 will not be eligible for appearing in the end term semester examination in that particular paper and will be deemed as 'Detained' in that paper. Such student will repeat the course/paper along with the regular students of examination of the course/paper.

13. Submission of Examinations Forms and Payment of Examination Fee:

The Dean, Faculty of Agricultural Sciences shall submit the examination admission forms of those students who satisfy the eligibility criteria to appear in the examinations to the Controller of Examinations as per schedule of examination circulated by him from time to time.

14. University Examinations:

i. End Term Semester Examinations:
The examination for the 1st and 3rd semesters (odd semester) shall ordinarily be held in the month of December and of the 2nd and 4th semesters (even semester) in the month of May/June. The examination dates are fixed by the controller of examination with the approval of the Vice Chancellor.

ii. Fail/ Re-appear candidates:
Fail / Re-appear candidate of the odd semester (1st & 3rd) will take re-appear exams as an ex- student in the subsequent exams of the odd semester (1st & 3rd). Similarly, for the even semesters (2nd & 4th), he/she will take re-appear exams in the subsequent exams of the even semesters (2nd& 4th). However a candidate appearing in the 4th semester examination (Regular) may appear simultaneously in his/her re-appear paper(s) of 1st and 3rd semesters.

15. Improvement Examinations:

The student may be permitted to improve his/her result subject to the following conditions:

i. The student will be permitted to appear in improvement examination as an ex-student with regular batches.
ii. The student will be permitted to improve his/her CGPA in one or all papers in which he/she has obtained CGPA less than 6.5 in aggregate.
iii. Only one chance per paper will be given. The chance must be availed within a year of initially passing of every semester examination.
iv. The candidate will be required to apply and allowed to appear only for theory examinations.
v. If the status/nature of the student's result does not improve by five (05) or more percent, his/her improvement result will be declared "PRS" (Previous Result Stands).
vi. The candidate shall be allowed to appear in the improvement examination(s) along with regular candidates as and when the course is offered. No separate examination will be held for improvement of result. In case of change of syllabi, the student shall have to appear for improvement in accordance with the changed of syllabi of the concerned course applicable to the regular students of that exam.

16. Setting of Question Papers:

Three sets of question paper shall be submitted in cover by concerned internal examiner to controller exam through proper channel. Controller examination shall choose one set for conducting end term examination.

17. Evaluation Process-Theory and Practical:

i. Evaluation of Answer Books:
The answer books may be evaluated either by the paper setter or by any other internal examiner to be nominated by the Dean, FASC.

ii. Re-evaluation of Answer Books:
Re-evaluation/ rechecking of any paper is allowed. The students can apply for Re-evaluation/ Re-checking of any paper to the controller of Examinations through the HOD/Deans of the Faculty within 10 days of the declaration of result by paying prescribed fee.

iii. Practical Examinations – Appointment of Examiner:
a. The practical examinations shall be conducted by internal examiner(s).
b. Marks Distribution as given at Serial 18.

18. Examination Schemes:

Theory paper: Total Marks= 70
Thirty marks (30) shall be assigned to each theory paper as internal assessment which shall be awarded as per the criteria given below:

1	**Attendance**	**5 Marks**
	Marks Distribution for Attendance	
	95 < = Attendance = 100%	5 Marks
	90 < = Attendance < 95%	4 Marks
	95 < = Attendance < 90%	3 Marks
	80 < = Attendance < 85%	2 Marks
	75 < = Attendance < 80%	1Mark
2	**First quiz**	**5 Marks**
3	**Midterm class test**	**15 Marks**
4	**Second quiz/ Assignment/ Seminar etc.**	**5 Marks**
End term examination		**40 Marks**

Practical paper: Total Marks = 30
The distribution of marks is given below:

1	Attendance	5 Marks
2	Regular experimental performance	10 Marks
3	Viva-Voce	5 Marks
4	Laboratory work report + Viva-voce	10 Marks

i. In case of ex-students, those appearing for re-appear / improvement examination in any semester, their previous internal assessment marks will be counted. If there is any change in scheme of Examination, and then Internal Assessment marks will be modified accordingly.

ii. The concerned teacher shall preserve records on the basis of which the Internal Assessment has been awarded and shall make the same available to the Controller of Examinations whenever required.

iii. The Head of the Department/ Dean of the Faculty shall ensure:
a. That the internal assessment marks are displayed for information of the students at least seven (07) days before the commencement of the examinations of each semester.
b. That the internal assessment marks are submitted to the Controller of Examination at least (07) days before the commencement of the examinations of each semester.

19. Criteria for promotion to Higher Semester / Pass Percentage:

The student shall be promoted to 2nd and 4th semester automatically without any condition of passing minimum number of papers. For promotion from 2nd and 3rd semester, the student shall have to clear at least 50% papers of 1st and 2nd semesters taken together.

20. Credit Based Grading System:

i. Key Definitions:

Programme	An educational programme leading to award of a Degree, Diploma or certificate.
Course	Usually referred to as 'paper' is a component of a programme. All courses need not carry the same weight.
Credit	A unit by which the course work is measured. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours for practical work/field work per week. A research Based Paper/Project is equal to 5 credits.
Credit Point	It is the product of grade point and number of credits for a course i.e. credit point = No. of credits in a course x "grade value" of the grade obtained in the course.
Grade Point Average(GPA)	There are two types of GPAs as given here under: Semester Grade Point Average (SGPA) Cumulative Grade Point Average (CGPA) Every student earns a distinct SGPA and a distinct CGPA at the end of each specified semester.
SGPA	SGOA is a measure for performance of student in a semester. It is the Point Average ratio of sum of the product of number of credits with grade points scored by the student in all the courses taken by him/her and the sum of the number of credits of all the courses undergone by the student i.e. $SGPA(Si)=\Sigma(Ci \times Gi)/\Sigma Ci$
CGPA	CGPA is a measure of performance up to any Grade. Grade specified semester Point Average beginning from the first semester. It is also calculated in the same (CGPA) manner as SPGA taking into account all the courses undergone by a student over all the semesters of programme i.e. $CGPA = \Sigma(Ci \times Si) / \Sigma Ci$
Grade Point	It is a numerical weight allotted to each letter grade on a 10-point scale
Letter Grades	It is an index of the performance of a student in a said course. The Grades are denoted by letters O, A+, A , B+

ii. Credits, Semesters, Courses and Total Credit Points:

S.No.	Course	Semesters	Major Credits	Minor Credits	Supporting Credit	Research Credit
1	M.Sc. Ag. (Agronomy)	4	21	9	5	20
2	M.Sc. Ag. Horticulture (Fruit Science)	4	21	9	5	20
3	M.Sc. Ag. Horticulture (Vegetable Science)	4	21	9	5	20
4	M.Sc. Ag. (Plant Pathology)	4	21	9	5	20

Grading Table

Range of Percentage of Marks	Letter Grade	Grade Point	Range of Grade Points	Classifications
90 and above	O (Outstanding)	10	9-10	Outstanding
80& above but less than 90	A+ (Excellent)	9	8 < 9	Excellent
70 & above but less than 90	A (Very Good)	8	7 < 8	1st Div with Distinction
60 & above but less than 70	B+ (Good)	7	6 < 7	1st Division
Less than 60	F (Fail)	0	0	Fail

Formula for calculating percentage of marks:

CGPA X 10 e.g. 6.53 X 10 = 65.3

Formula for Grade Point calculations:
G = (Marks Obtained in Paper/Total marks of paper) x 100

Formula for computations SGPA & CGPA

i. The SGPA is the ratio of sum of the product of the number of credits with the grade point scored by the students in all the courses taken by a students and the sum of the number of credits of all the courses taken by the students, i.e.

$$SGPA(Si) = \Sigma(Ci \times Gi) / \Sigma Ci ,$$

Where Ci is the no. of credits of the ith course and Gi is the grade point scored by the student in the ith course

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by the students over all the students over all the semesters of the programme , i.e

$$CGPA = \Sigma(Ci \times Si) / \Sigma Ci$$

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded up to 2 decimal points and reported in the transcripts. Result – Cum-Detailed Marks Card/ Transcript: Based on the above recommendation on letter grades, grade points and SGPA and CGPA, the DMC/ Transcript for each semester and a consolidated transcript indicating the performance in all semester may be issued.

iv. Illustration of computation of SGPA and CGPA and format for transcripts

Course	Credit	Grade Letter	Grade Point	Credit Points (Credit x Grade)
Course 1	3	A	8	$3 \times 8 = 24$
Course 2	4	B+	7	$4 \times 7 = 28$
Course 3	3	B+	7	$3 \times 7 = 21$
Course 4	3	O	10	$3 \times 10 = 30$
Course 6	4	B+	7	$4 \times 7 = 28$
	17			131

Thus, SGPA = 131/17 = 7.70

Similarly, suppose the SGPA for 2nd, 3rd and 4th semester are 7.85, 5.6,and 6.0 with credits 22, 24 and 22 respectively, then for a two year PG Programme, the CGPA will be computed as followed,

CGPA = $(20 \times 6.95 + 22 \times 7.85 + 24 \times 5.6 + 22 \times 6.0)/88 = 6.57$

Course	Credits	Grade Letter	Grade Point Block	Range of Grade points (Actual Grade value as per marks obtained)	Earned Credit Point (Credit × Actual Grade Value)
Course 1	3	O	10	9.2	3×9.2=27.6
Course 2	3	A+	9	8.2	3×8.2=24.6
Course 3	4	A	8	7	4×7=28
Course 4	3	B+	7	6.7	3×6.7=27.6
	13				107.8

Thus, SGPA = 107.8/13 = 8.29

Similarly, suppose SGPA for 2nd, 3rd and 4th semester are 7.85, 5.6 and 6.0 with credits 22, 24 and 22, respectively
CGPA = (20 × 6.79 + 22 × 7.85 + 24 × 5.6 + 22 ×6.0)/88 = 6.53

Calculating percentage of marks
CGPA × 10 e.g. 6.53 × 10 = 65.3

21. Pass criteria:

The pass percentage for Internal will be 40% to be eligible to appear in End Term Examination (theory and practical), whereas overall pass percentage will be 60% including theory, practical and internal. The minimum CGPA for award of degree will be 6.5 on 10 scales.

22. Declaration of Results:

i. The Controller of Examination shall declare the results as early as possible after the conclusion of each examination, but before the start of teaching for the next academic session.
ii. Each successful student/ the student placed in reappear shall receive a copy of the Detailed Marks Certificate/ Grade Card Sheet of each semester examination.
iii. The student whose result is declared late without any fault on his/her part may attend the classes for next higher semester provisionally at his/her own risk and responsibility, subject to his/her passing the concerned semester examination. In case, the student fails to pass the concerned semester examination, his/her attendance/internal assessment in the next higher semester in which he/she was allowed to attend classes provisionally will stand cancelled.

23. Other Provisions:

i. Nothing in the ordinance shall debar the University from amending the ordinance and the same shall be applicable to all the students whether old or new.
ii. Any other provision not contained in the ordinance shall be governed by the rules and regulations framed by the University from time to time.
iii. In case of any dispute, the Vice-chancellor will be competent authority to interpret the rules and his interpretation shall be final.

M.Sc. Ag. (Agronomy)

CONTENTS

1. Executive Summary

The role of agronomy is significant in agro eco-system. Understanding the growth, development, mechanisms of photosynthesis, photorespiration, nitrogen fixation and other metabolic pathways, behaviour of enzymes, development of fermentation technologies and modern biology tools have changed the trend in agronomical research. The advancement made in last few decades in agronomy is now reflected in teaching and research in allied agricultural sciences. There has been more use of modern techniques in crop production, mineral nutrition, chemical analysis of soil, plant and various agricultural products. Courses on cereals, pulses, oilseeds, weed management, climatology, fertilizer management, organic farming, irrigation management, water shed management and crop modeling has become necessary for improving the quality of education leading to post graduates passing out with applied knowledge including skill and entrepreneurship. Haryana is primarily an agricultural state with 70% of population pre-dominantly engaged in agriculture. Haryana is self-sufficient in food production and the second largest contributor to India's central pool of food grains with the scope of education to sustain productivity and soil fertility. The main crops of Haryana are wheat, rice, sugarcane, cotton, oilseeds, gram, barley, corn and millet etc.

The existing M.Sc. **Ag. (Agronomy)** programme running at national level is inadequate to meet the present and envisaged human resource requirement. The programme needs to be expanded as done in the Syllabus of Agronomy in Agricultural Scientists Recruitment Board (ASRB) Examinations. The envisaged M. Sc. programmes are:

1.1. Organization of Course Contents & Credit Requirements

1.1.1. General Information about Course Code Numbers

i). All courses for M.Sc. Ag. (Agronomy) are of 500-series.

ii). Credit seminar has been designated by code no. 591, while code no. 599 pertains for Master's Research.

1.1.2. General Information about Course Contents

The contents of each course have been organized into:

i). Objective (s) – to elucidate the basic purpose.

ii). Theory units – to facilitate uniform coverage of syllabus for paper setting.

iii). Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.

1.1.3. Minimum Credit Requirement

Subject*	**Master's Programme**
Major	20
Minor	09
Supporting	05
Seminar	01
Research	20
Total Credits	55
Compulsory Non Credit Courses	Section 5

***Major subject: The subject (discipline) in which the students takes admission.
Minor subject: The subject closely related to major subject.

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.
Non-Credit Compulsory Courses: Please see Section 5 for details. Six courses are of general nature and are compulsory for Master's programme.

2. MAJOR SUBJECT

2.1. Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
AGRON 501*	11060108	MODERN CONCEPTS IN CROP PRODUCTION	3(3+0)
AGRON 502*	11060207	PRINCIPLES AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT	3(2+1)
AGRON 503*	11060209	PRINCIPLES AND PRACTICES OF WEED MANAGEMENT	3(2+1)
AGRON 504*	11060210	PRINCIPLES AND PRACTICES OF WATER MANAGEMENT	3(2+1)
AGRON 505	11060109	AGROMETEOROLOGY AND CROP WEATHER FORECASTING	3(2+1)
AGRON 506	11060110	AGRONOMY OF MAJOR CEREALS AND PULSES	3(2+1)
AGRON 511	11060211	CROPPING SYSTEM	2(2+0)
AGRON 591	11060405	MASTER'S SEMINAR	1(1+0)
AGRON 599	11060406	MASTER'S RESEARCH	

*Compulsory Course
Course numbers are as per ICAR recommendation and guidelines.

2.1.1 Course Content

11060108: MODERN CONCEPTS IN CROP PRODUCTION 3(3+0)

Objective
To teach the basic concepts of soil management and crop production.

Theory
UNIT-I
Crop growth analysis in relation to environment; geo-ecological zones of India.

UNIT-II
Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.
UNIT-III

Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

UNIT-IV
Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.

UNIT-V
Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture.

Suggested Readings

- Balasubramaniyan P & Palaniappan SP. 2001. *Principles and Practices of Agronomy*. Agrobios.
- Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.
- Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.
- Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.
- Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publ.
- Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.
- Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

11060207: PRINCIPLES AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT 3(2+1)

Objective

To impart knowledge of fertilizers and manures as sources of plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil fertility.

Theory

UNIT-I
Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.

UNIT-II
Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

UNIT-III
Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management.

UNIT-IV
Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interactions.

UNIT-V
Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermincompost and residue wastes in crops.

Practical

• Determination of soil pH, EC, organic C, total N, available N, P, K and S in soils
• Determination of total N, P, K and S in plants
• Interpretation of interaction effects and computation of economic and yield optima

Suggested Readings

- Brady NC & Weil R.R 2002. *The Nature and Properties of Soils.* 13th Ed. Pearson Edu.
- Fageria NK, Baligar VC & Jones CA. 1991. *Growth and Mineral Nutrition of Field Crops.* Marcel Dekker.
- Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers.* 7th Ed. Prentice Hall.
- Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture.* CRC Press.
- Yawalkar KS, Agrawal JP & Bokde S. 2000. *Manures and Fertilizers*. Agri-Horti Publ.

11060209: PRINCIPLES AND PRACTICES OF WEED MANAGEMENT 3(2+1)

Objective

To familiarize the students about the weeds, herbicides and methods of weed control.

Theory

UNIT-I

Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices.

UNIT-II

Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.

UNIT-III

Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio-herbicides, myco-herbicides and allelochemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation.

UNIT-IV

Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control.

UNIT-V

Integrated weed management; cost : benefit analysis of weed management.

Practical

• Identification of important weeds of different crops
• Preparation of a weed herbarium
• Weed survey in crops and cropping systems
• Crop-weed competition studies
• Preparation of spray solutions of herbicides for high and low-volume sprayers
• Use of various types of spray pumps and nozzles and calculation of swath width
• Economics of weed control
• Herbicide resistance analysis in plant and soil
• Bioassay of herbicide resistance

• Calculation of herbicidal requirement

Suggested Readings

- Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.
- Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley Inter-Science.
- Gupta OP. 2007. *Weed Management – Principles and Practices.* Agrobios.
- Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.
- Rao VS. 2000. *Principles of Weed Science*. Oxford & IBH.
- Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani.
- Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic
- Press.

11060210: PRINCIPLES AND PRACTICES OF WATER MANAGEMENT 3(2+1)

Objective

To teach the principles of water management and practices to enhance the water productivity.

Theory

UNIT-I

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

UNIT-II

Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition.

UNIT-III

Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; microirrigation system; fertigation; management of water in controlled environments and polyhouses.

UNIT-IV

Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency.

UNIT-V

Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.

Practical

• Measurement of soil water potential by using tensiometer, and pressure plate and membrane apparatus
• Soil-moisture characteristics curves
• Water flow measurements using different devices
• Determination of irrigation requirements
• Calculation of irrigation efficiency
• Determination of infiltration rate
• Determination of saturated/unsaturated hydraulic conductivity

Suggested Readings

- Lenka D. 1999. *Irrigation and Drainage*. Kalyani
- Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.

- Paliwal KV. 1972. *Irrigation with Saline Water*. IARI Monograph, New Delhi.
- Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.
- Prihar SS & Sandhu BS. 1987. *Irrigation of Food Crops - Principles and Practices*. ICAR.
- Reddy SR. 2000. *Principles of Crop Production*. Kalyani.
- Singh Pratap & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publ.

11060109: AGROMETEOROLOGY AND CROP WEATHER FORECASTING 3(2+1)

Objective

To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

Theory

UNIT-I

Agro meteorology - aim, scope and development in relation to crop environment; composition of atmosphere, distribution of atmospheric pressure and wind.

UNIT-II

Characteristics of solar radiation; energy balance of atmosphere system; radiation distribution in plant canopies, radiation utilization by field crops; photosynthesis and efficiency of radiation utilization by field crops; energy budget of plant canopies; environmental temperature: soil, air and canopy temperature.

UNIT-III

Temperature profile in air, soil, crop canopies; soil and air temperature effects on plant processes; environmental moisture and evaporation: measures of atmospheric temperature and relative humidity vapor pressure and their relationships; evapo-transpiration and meteorological factors determining evapotranspiration.

UNIT-IV

Modification of plant environment: artificial rain making, heat transfer, controlling heat load, heat trapping and shading; protection from cold, sensible and latent heat flux, controlling soil moisture; monsoon and their origin, characteristics of monsoon; onset, progress and withdrawal of monsoon; weather hazards, drought monitoring and planning for mitigation.

UNIT-V

Weather forecasting in India – short, medium and long range; aerospace science and weather forecasting; benefits of weather services to agriculture, remote sensing; application in agriculture and its present status in India; atmospheric pollution and its effect on climate and crop production; climate change and its impact on agriculture.

Practical

• Visit to agro-meteorological observatory and to record sun-shine hours, wind velocity, wind direction, relative humidity, soil and air temperature, evaporation, precipitation and atmospheric pressure
• Measurement of solar radiation outside and within plant canopy
• Measurement/estimation of evapo-transpiration by various methods
• Measurement/estimation of soil water balance
• Rainfall variability analysis
• Determination of heat-unit requirement for different crops
• Measurement of crop canopy temperature
• Measurement of soil temperatures at different depths
• Remote sensing and familiarization with agro-advisory service bulletins
• Study of synoptic charts and weather reports, working principle of

automatic weather station
• Visit to solar observatory

Suggested Readings

- Chang Jan Hu 1968. *Climate and Agriculture on Ecological Survey*. Aldine Publ.
- Critchfield HJ.1995. *General Climatology.* Prentice Hall of India.
- Das PK.1968. *The Monsoons.* National Book Trust Publ.
- Lal DS.1998. *Climatology*. Sharda Pustak Bhawan.
- Lenka D.1998. *Climate, Weather and Crops in India*. Kalyani.
- Mavi H.S.1994. *Introduction to Agro-meteorology.* Oxford & IBH.
- Mavi HS & Tupper GJ. 2004. *Agrometeorology: Principles and Application of Climate Studies in Agriculture.* Haworth Press.
- Menon PA.1991. *Our Weather.* National Book Trust Publ.
- Sahu DD. *Agrometeorology and Remote Sensing: Principles and Practices*. Agrobios.
- Variraju R & Krishnamurty 1995. *Practical Manual on AgriculturalMeteorology*. Kalyani.
- Varshneya MC & Balakrishana Pillai P. 2003. *Textbook of AgriculturalMeteorology*. ICAR.

11060110: AGRONOMY OF MAJOR CEREALS AND PULSES 3(2+1)

Objective

To teach students, the crop husbandry of cereals and pulse crops.

Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of:

UNIT-I
Rabi cereals.

UNIT-II
Kharif cereals.
UNIT-III
Rabi pulses.

UNIT-IV
Kharif pulses.

Practical

• Phenological studies at different growth stages of crop
• Estimation of crop yield on the basis of yield attributes
• Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities
• Working out growth indices (CER, CGR, RGR, NAR, LAD), aggressiveness, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems of different crops
• Estimation of protein content in pulses
• Planning and layout of field experiments
• Judging of physiological maturity in different crops
• Intercultural operations in different crops
• Determination of cost of cultivation of different crops
• Working out harvest index of various crops
• Study of seed production techniques in various crops

• Visit of field experiments on cultural, fertilizer, weed control and water management aspects
• Visit to nearby villages for identification of constraints in crop production

Suggested Readings

- Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.
- Hunsigi G & Krishna KR. 1998. *Science of Field Crop Production*. Oxford & IBH.
- Jeswani LM & Baldev B. 1997. *Advances in Pulse Production Technology*. ICAR.
- Khare D & Bhale MS. 2000. *Seed Technology*. Scientific Publ.
- Kumar Ranjeet & Singh NP. 2003. *Maize Production in India: Golden Grain in Transition*. IARI, New Delhi.
- Pal M, Deka J & Rai RK. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill.
- Prasad, Rajendra. 2002. *Text Book of Field Crop Production*. ICAR.
- Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.
- Singh, SS. 1998. *Crop Management*. Kalyani.
- Yadav DS. 1992. *Pulse Crops*. Kalyani.

11060211: CROPPING SYSTEM 2(2+0)

Objective

To acquaint the students about prevailing cropping systems in the country and practices to improve their productivity.

Theory

UNIT-I

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

UNIT-II

Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

UNIT-III

Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

UNIT-IV

Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system.

UNIT-V

Plant ideotypes for drylands; plant growth regulators and their role in sustainability.

Suggested Readings

- Palaniappan SP & Sivaraman K. 1996. *Cropping Systems in the Tropics;Principles and Management*. New Age.
- Panda SC. 2003. *Cropping and Farming Systems*. Agrobios.
- Reddy SR. 2000. *Principles of Crop Production*. Kalyani.
- Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ. Co.
- Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

- Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1997. *Soil Fertility and Fertilizers*. Prentice Hall.

3. MINOR SUBJECT (Soil Science)

3.1. Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
SOILS 505	11060403	SOIL EROSION AND CONSERVATION	3(2+1)
SOILS 511	11060105	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	2(0+2)
SOILS 513	11060112	MANAGEMENT OF PROBLEMATIC SOILS AND WATERS	3(2+1)
SOILS 514	11060402	FERTILIZER TECHNOLOGY	1(1+0)

3.1.1. Course Content

11060403: SOIL EROSION AND CONSERVATION 3(2+1)

Objective

To enable students to understand various types of soil erosion and measures to be taken for controlling soil erosion to conserve soil and water.

Theory

UNIT-I

History, distribution, identification and description of soil erosion problems in India.

UNIT-II

Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI30 index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

UNIT-III

Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.

UNIT-IV

Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.

UNIT-V

Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

UNIT-VI

Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical

• Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index
• Computation of kinetic energy of falling rain drops
• Computation of rainfall erosivity index (EI30) using rain gauge data
• Visits to a watersheds

Suggested Readings

- Biswas TD & Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Society of Soil Science No. 17.
- Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality.* Soil Science Society of America, Spl Publ. No. 49, Madison, USA.
- Gurmal Singh, Venkataramanan C, Sastry G & Joshi BP. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.
- Hudson N. 1995. *Soil Conservation.* Iowa State Univ. Press. Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
- Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

11060105: ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS 2(0+2)

Objective

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Practical

UNIT-I

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

UNIT-II

Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

UNIT-III

Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods.

UNIT-IV

Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

UNIT-V

Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.

UNIT-VI

Determination of lime and gypsum requirement of soil; drawing normalized exchange isotherms; measurement of redox potential.

UNIT-VII
Analysis of soil extracts and irrigation waters for their soluble cations and anions and interpretation of results.

Suggested Readings

- Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons.
- Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
- Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.
- Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.
- Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
- Piper CE. *Soil and Plant Analysis*. Hans Publ.
- Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis - AMethods Manual*. IARI, New Delhi.
- Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.
- Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.
- Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

11060112: MANAGEMENT OF PROBLEMATIC SOILS AND WATERS 3(2+1)

Objective

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

UNIT-I
Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible**.**

UNIT-II
Morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties.

UNIT-III
Management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils.

UNIT-IV
Acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management.

UNIT-V
Quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality.

UNIT-VI
Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical

• Characterization of acid, acid sulfate, salt-affected and calcareous soils

• Determination of cations (Na+, K+, Ca++ and Mg++) in ground water and soil samples
• Determination of anions (Cl-, SO4 --, CO3 -- and HCO3 -) in ground waters and soil samples
• Lime and gypsum requirements of acid and sodic soils

Suggested Readings

- Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.
- Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.
- USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

11060402: FERTILIZER TECHNOLOGY 1(1+0)

Objective

To impart knowledge about how different fertilizers are manufactured using different kinds of raw materials and handling of fertilizers and manures.

Theory

UNIT-I

Fertilizers – production, consumption and future projections with regard to nutrient use in the country and respective states; fertilizer control order.

UNIT-II

Manufacturing processes for different fertilizers using various raw materials, characteristics and nutrient contents.

UNIT-III

Recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order.

UNIT-IV

New and emerging issues in fertilizer technology – production and use of slow and controlled release fertilizers, super-granules fertilizers and fertilizers for specific crops/situations.

Suggested Readings

- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils.* Pearson Edu.
- *Fertilizer (Control) Order, 1985 and the Essential Commodities Act*. FAI New Delhi.
- Kanwar JS. (Ed.). 1976. *Soil Fertility: Theory and Practice*. ICAR.
- Olson RA, Army TS, Hanway JJ & Kilmer VJ. 1971. *Fertilizer Technology and Use.* 2nd Ed. Soil Sci. Soc. Am. Madison.
- Prasad R & Power JF. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
- Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility andFertilizers.* McMillan Publ.
- Vogel AI. 1979. *Textbook of Quantitative Inorganic Analysis*. ELBS.

4. BASIC SUPPORTING COURSES

4.1. Courses' structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
STAT 512	11060203	EXPERIMENTAL DESIGNS	3(2+1)
STAT 513	11060308	SAMPLING TECHNIQUES	3(2+1)

4.1.1. Course Content

11060203: EXPERIMENTAL DESIGNS 3(2+1)

Objective

This course is meant for students of agricultural and other related sciences. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

UNIT-I

Need for designing of experiments, characteristics of a good design. Basic principles of designs - randomization, replication and local control.

UNIT-II

Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

UNIT-III

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

UNIT-IV

Split plot and strip plot designs; Analysis of covariance and missingplot techniques in randomized block and Latin square designs;Transformations, crossover designs, balanced incomplete block design, Lattice design, Response surfaces.

UNIT-V

Bioassays- direct and indirect, potency estimation.

Practical

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Fitting of response surfaces and Bioassays.

Suggested Readings

- Cochran WG & Cox GM. 1957. *Experimental Designs*. 2nd Ed. John Wiley. Dean AM & Voss D. 1999. *Design and Analysis of Experiments*. Springer. Federer WT. 1985. *Experimental Designs*. MacMillan.
- Fisher RA. 1953. *Design and Analysis of Experiments. Oliver & Boyd.*
- Nigam AK & Gupta VK. 1979. *Handbook on Analysis of Agricultural Experiments. IASRI Publication*
- Pearce SC. 1983. *The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.*
- Design Resources Server: www.iasri.res.in /design.

11060308: SAMPLING TECHNIQUES 3(2+1)

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. The students would be exposed to elementary sampling techniques. It would help them in understanding the concepts involved in

planning and designing their surveys, presentation of survey data analysis of survey data and presentation of results. This course would be especially
important to the students of social sciences.

Theory

UNIT-I

Concept of sampling, sample survey vs complete enumeration, planning of sample survey, sampling from a finite population.

UNIT-II

Simple random sampling, sampling for proportion, determination of sample size; inverse sampling, Stratified sampling.

UNIT-III

Cluster sampling, PPS sampling, Multi-stage sampling, double sampling, systematic sampling; Use of auxiliary information at estimation as well as selection stages.

UNIT-IV

Ratio and regression estimators. Construction and analysis of survey designs, sampling and non-sampling errors; Preparation of questionnaire Non-sampling errors.

Practical

Random sampling ~ use of random number tables, concepts of unbiasedness, variance, etc.; simple random sampling, determination of sample size; Exercises on inverse sampling, stratified sampling, cluster sampling and systematic sampling; Estimation using ratio and regression
estimators; Estimation using multistage design, double sampling and PPS sampling.

Suggested Readings

- Cochran WG. 1977. *Sampling Techniques.* John Wiley.
- Murthy MN. 1977. *Sampling Theory and Methods*. 2nd Ed. Statistical Publ.Soc., Calcutta.
- Singh D, Singh P & Kumar P. 1982. *Handbook on Sampling Methods*.IASRI Publ.
- Sukhatme PV, Sukhatme BV, Sukhatme S & Asok C. 1984. *Sampling Theory of Surveys with Applications.* Iowa State University Press and Indian Society of Agricultural Statistics, New Delhi.

5. COMPULSORY NON-CREDIT COURSES

5.1. Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
PGS 501	11060111	LIBRARY AND INFORMATION SERVICES	1(0+1)
PGS 502	11060204	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	1(0+1)
PGS 503	11060205	INTELLECTUAL PROPERTY & ITS MANAGEMENT IN AGRICULTURE (e-Course)	1(1+0)
PGS 504	11060206	BASIC CONCEPTS IN LABORATORY TECHNIQUES	1(0+1)
PGS 505	11060306	AGRICULTURAL RESEARCH, RESEARCH ETHICS & RURAL DEVELOPMENT PROGRAMMES (e-Course)	1(1+0)
PGS 506	11060106	DISASTER MANAGEMENT (e-Course)	1(1+0)

5.1.1 Course Content

11060111: LIBRARY AND INFORMATION SERVICES 1(0+1)

Objective

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

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

11060204: TECHNICAL WRITING AND COMMUNICATIONS SKILLS 1(0+1)

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical writing

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

Communication skills

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

Suggested Readings

- Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek, Chandigarh. Chicago Manual of Style. 14th Ed. 1996. Prentice-Hall of India, New Delhi.
- Collins' Cobuild English Dictionary. 1995. Harper Collins, New York.
- Gibaldi, Joseph. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press, New Delhi.
- Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford UP, Oxford.
- Krishna Mohan 2005. Speaking English Effectively. Macmillan India, New Delhi.
- Mills Gordon H & John A Walter. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston, New York.

- Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice-Hallof India, New Delhi.
- Shelton James H. 1994. Handbook for Technical Writing. NTC Business Books, Chicago. Smith Richard W. 1969. Technical Writing. Barnes & Noble, New York.
- Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand, New Delhi.

11060205: INTELLECTUAL PROPERTY & ITS MANAGEMENT IN AGRICULTURE (e-Course) 1(1+0)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR), related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

- Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI, Wallingford.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw- Hill, New Delhi. India,
- Intellectual Property Rights: Key to New Wealth Generation.2001. NRDC and Aesthetic Technologies, New Delhi.
- Ministry of Agriculture. GoI., 2004. State of Indian Farmer. Vol. 5. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild, Max & Newman, Scott (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya, Delhi.
- The Indian Acts - Patents Act, 1970 & amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 & amendments; Layout Design Act, 2000; PPV & FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

11060206: BASIC CONCEPTS IN LABORATORY TECHNIQUES 1(0+1)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of

buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings

- *Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.*
- Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

11060306: AGRICULTURAL RESEARCH, RESEARCH ETHICS & RURAL DEVELOPMENT PROGRAMMES (e-Course) 1(1+0)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT-I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT-II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT-III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP), Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

- Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development. Sage Publ.* Punia MS. *Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.*
- Rao BSV. 2007. *Rural Development Strategies and Role of Institutions -Issues, Innovations and Initiatives. Mittal Publ.*
- Singh K. 1998. *Rural Development - Principles, Policies and Management. Sage Publ.*

11060106: DISASTER MANAGEMENT (E-Course) 1(1+0)

Objective

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT-I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.

UNIT-II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT-III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations and media. Central, State, District and Local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

- Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.
- Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management. Routledge.*

M.Sc. Ag. Horticulture (Fruit Science)

CONTENTS

1. Executive Summary

Horticulture plays a pivotal role in the food and livelihood security in India.Though, horticultural crops occupy only 8.5% of arable land, they contribute 24.5% of theGDP in agriculture. Plantation crops (tea, coffee, rubber, etc.) occupying 0.95% of croppedarea and have stake of 15.1% of the total export earnings. Economists view thatcommercialization of agriculture and promotion of agri-business in India is correlated tothe progress in the plantation and horticulture sectors. Horticulture and Plantation sectorscover production, post-harvest management, marketing, processing and export of fruits,vegetables, flowers, medicinal and aromatic plants, plantation crops, spices, bamboo,mushroom, apiculture and sericulture. On the total production side, India leads the wholeworld in fruits and vegetables next to China. The performance in production is laudable however, in value addition, processing andexport segments, India's contribution is not as expected. In spite of having a 10% share in global production of both fruits and vegetables, just 1.8% of it is processed.Horticulture has gained importance in Haryana as a separate viable economic activity. With the sustained efforts of government, considerable progress has been made in fruits, vegetables, flowers and mushroom cultivation.Trough research studies it has also been concluded that horticulture can be a viable option for diversifying the irrigation water intensive field crop based systems, particularly the Rice-Wheat cropping system in the states of Punjab and Haryana, where the water table is going down at an alarming rate. Haryana has total 4.42 million ha land area out of which 3.55 m ha is cultivable. Of the total State Economy of Haryana horticulture share is 6 % and that of GDP is 15.3%.

The existing single M. Sc. (Hort.) programme running at national level is inadequate to meet thepresent and envisaged human resource requirement. The programme needs to be expandedas done in the Syllabus of Horticulture in Agricultural Scientists Recruitment Board(ASRB)Examinations. The envisaged M. Sc. programmes are:

1. M. Sc. (Horticulture) - Fruit Science
2. M. Sc. (Horticulture) - Vegetable Science
3. M. Sc. (Horticulture - Floriculture and Landscape Architecture
4. M. Sc. (Horticulture) - Plantation crops, Spices, Medicinal and Aromatic Crops

Keeping pace with the latest development in agriculture the SGTU started M.Sc. Horticulture (Fruit Science) in the first phase of starting Master's Degree programmes in Agriculture as per ICAR guidelines.

1.1. Organization of Course Contents & Credit Requirements

1.1.1. General Information about Course Code Numbers

i). All courses for M.Sc. Ag. Horticulture (Fruit Science) will be of 500-series.

ii). Credit seminar has been designated by code no. 591, while code no. 599 pertains for Master's Research.

1.1.2. General Information about Course Contents

The contents of each course have been organized into:

i). Objective (s) – to elucidate the basic purpose.

ii). Theory units – to facilitate uniform coverage of syllabus for paper setting.

iii). Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.

iv). E-Resources - This may be useful as study material for research topics/ for quick update on specific topics/events pertaining to the subject.

1.1.3. Minimum Credit Requirement

Subject*	**Master's Programme**
Major	20
Minor	09
Supporting	05
Seminar	01
Research	20
Total Credit	55
Compulsory Non-Credit Courses	Section 5

***Major subject: The subject (department) in which the student takes admission

Minor subject: The subject closely related to student's major subject.

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.

Compulsory Non-Credit Courses: Please see Annexure-I for details. Six courses (PGS 501 to PGS 506) are of general nature and are compulsory for Master's programme.

2. Major Subject Courses

2.1. Courses' Structure at a Glance

Course Code (ICAR pattern)	**Course Code (SGTU pattern)**	**Course Title**	**Credits**
FSC 501*	11060101	TROPICAL AND DRY LAND FRUIT PRODUCTION	3(2+1)
FSC 502*	11060102	SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION	3(2+1)

FSC 503*	11060201	BIODIVERSITY AND CONSERVATION OF FRUIT CROPS	3(2+1)
FSC 505	11060302	PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS	3(2+1)
FSC 506*	11060301	BREEDING OF FRUIT CROPS	3(2+1)
FSC 507	11060103	POST HARVEST TECHNOLOGY FOR FRUIT CROPS	3(2+1)
FSC 512	11060303	GAP FOR HORTICULTURAL CROPS	1(1+0)
FSC 513	11060104	CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION	1(1+0)
FSC 591	11060405	MASTER'S SEMINAR	1(1+0)
FSC 599	11060406	MASTER'S RESEARCH	20

***** Compulsory Course

2.1.1 Course Content

FSC 501/11060101: TROPICAL AND DRY LAND FRUIT PRODUCTION 3(2+1)

Objective

To impart basic knowledge about the importance and management of tropical and dry land fruits grown in India.

Theory

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

Crops

UNIT-I

Mango and Banana

UNIT-II

Citrus and Papaya

UNIT-III

Guava,Sapota and Jackfruit

UNIT-IV

Pineapple, Annonas and Avocado

UNIT-V

Ber, Aonla, Bael, Pomegranate, Phalsa, Karonda, Mulberry, Ker, Salvadora, Lasoda and, minor fruits of tropics

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, project preparation for establishing commercial orchards.

Suggested Readings

- Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits -Horticulture*. Allied Publ.
- Bose TK, Mitra SK & Sanyal D. 2001. (Eds.). *Fruits -Tropical and Subtropical*. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vols. II–IV, Malhotra Publ. House.
- Nakasone HY & Paul RE. 1998. *Tropical Fruits*. CABI.
- Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency.
- Pradeepkumar T, Suma B, Jyothibhaskar&Satheesan KN. 2008. *Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Singh HP, Negi JP & Samuel JC. (Eds.). 2002. *Approaches for Sustainable Development of Horticulture*. National Horticultural Board.
- Singh HP, Singh G, Samuel JC & Pathak RK. (Eds.). 2003. *Precision Farming in Horticulture*. NCPAH, DAC/PFDC, CISH, Lucknow.

FSC 502/11060102: SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 3(2+1)

Objective

To impart basic knowledge about the importance and management of subtropical and temperate fruits grown in India.

Theory

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, biotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones (AEZ) and industrial support.

Crops

UNIT-I

Apple, pear, quince, grapes

UNIT-II

Plums, peach, apricot, cherries, hazelnut

UNIT-III

Litchi, loquat, persimmon, kiwifruit, strawberry

UNIT-IV

Nuts- walnut, almond, pistachio, pecan

UNIT-V

Minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to subtropical and temperate orchards, Project preparation for establishing commercial orchards.

Suggested Readings

- Bose TK, Mitra SK &Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*.3rd Ed. Vols. I, II. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.
- *Chadha KL &Shikhamany SD. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.*
- Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

FSC 503/11060201: BIODIVERSITY AND CONSERVATION OF FRUIT CROPS 3(2+1)

Objective

Understanding the principles of biodiversity and strategies in germplasm conservation of fruit crops.

Theory

UNIT-I

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.

UNIT-II

Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ.*

UNIT-III

Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

UNIT-IV

Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

UNIT-V

GIS and documentation of local biodiversity, Geographical indication.

Crops

Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard apple, ber, aonla, Malus spp., *Prunus* spp., litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

Practical

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

Suggested Readings

- Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.*
- Peter KV & Abraham Z. 2007. *Biodiversity in Horticultural Crops*. Vol.I. Daya Publ. House.
- Peter KV. 2008. *Biodiversity of Horticultural Crops*. Vol. II. Daya Publ. House.

FSC 505/11060302: PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS 3(2+1)

Objective

Familiarization with principles and practices of propagation and nursery management for fruit crops.

Theory

UNIT-I

Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

UNIT-II

Seed quality, treatment, packing, storage, certification, testing. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

UNIT-III

Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working – Progeny orchard and scion bank.

UNIT-IV

Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.

UNIT-V

Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

Practical

Anatomical studies in rooting of cutting and graft union, construction of propagation structures, study of media and PGR. Hardening – case studies, micropropagation, explant preparation, media preparation, culturing – *in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening. Visit to TC labs and nurseries.

Suggested Readings

- Hartmann HT & Kester DE. 1989. *Plant Propagation – Principles and Practices. Prentice Hall of India.*
- Bose TK, Mitra SK & Sadhu MK. 1991. *Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash.*
- Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency. Singh SP. 1989 *Mist Propagation*. Metropolitan Book Co.
- Rajan S & Baby LM. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

FSC 506/11060301: BREEDING OF FRUIT CROPS 3(2+1)

Objective

To impart comprehensive knowledge about the principles and practices of breeding of fruit crops.

Theory

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

Crops

UNIT-I

Mango, banana and pineapple

UNIT-II

Citrus, grapes, guava and sapota

UNIT-III

Jackfruit, papaya, custard apple, aonla, avocado and ber

UNIT-IV

Mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam and nuts

UNIT-V

Apple, pear, plums, peach, apricot, cherries and strawberry

Practical

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

Suggested Readings

- Bose TK, Mitra SK &Sanyol D. (Eds.). 2002. *Fruits of India – Tropical and Sub-tropical*.3rd Ed. Vols. I, II. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.
- Chadha KL &Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.*
- Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

FSC 507/11060103: POST HARVEST TECHNOLOGY FOR FRUIT CROPS 3(2+1)

Objective

To facilitate deeper understanding on principles and practices of postharvest management of fruit crops.

Theory

UNIT-I

Maturity indices, harvesting practices for specific market requirements, influence of pre- harvest practices, enzymatic and textural changes, respiration, transpiration.

UNIT-II

Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT-III

Treatments prior to shipment, *viz*., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage ventilation, refrigeration, modified atmospheric storage, controlled atmospheric storage, physical injuries and disorders.

UNIT-IV

Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

UNIT-V

Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical

Analyzing maturity stages of commercially important fruit crops, improved packing and storage of important fruit crops, physiological loss in weight of fruits, estimation of transpiration, respiration rate, estimation of quality characteristics in stored fruits, cold chain management visit to cold storage and CA storage units, visit to fruit processing units, project preparation, evaluation of processed fruit products.

Suggested Readings

- Bhutani RC. 2003. *Fruit and Vegetable Preservation*. Biotech Books.
- Chadha KL & Pareek OP. (Eds.). 1996 *Advances in Horticulture*. Vol. IV. Malhotra Publ. House.
- Haid NF &Salunkhe SK. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables. Grenada Publ.*
- Mitra SK. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CABI.*
- Ranganna S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill.*
- Sudheer KP & Indira V. *2007. Post Harvest Technology of Horticultural Crops. New India Publ. Agency.*
- Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. *Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.

FSC 512/11060303: GAP FOR HORTICULTURAL CROPS 1(1+0)

Objective

To impart comprehensive knowledge about the principles and practices of Good Agricultural Practises (GAP) for horticultural crops.

Theory

UNIT-I

Genesis of GAP – definition/description, components listed by FAO, frame work.

UNIT-II

Management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection. Identification of ways of improving the productivity profitability, and resource efficiency. harvest and post-harvest handling.

UNIT-III

Animal production, product certification, animal waste management, animal health and welfare, harvest.

UNIT-IV

On farm processing, storage, energy and waste management, human health, welfare, safety, wild life benefits.

UNIT-V

Institutions involved in GAP certification. Indian agencies, EUREPGAP (European Retail Producers Group- Good Agricultural Practices), EUREP etc.

Suggested Readings

- Peter KV. 2008. *Basics in Horticulture*. New India Publ. Agency.

FSC 513/11060104: CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION 1(1+0)

Objective

To develop understanding about the impact and management of climate in horticultural production.

Theory

UNIT-I

Introduction to climate change. Factors directly connected to climate change, average temperature, change in rainfall amount and patterns, rising atmospheric concentrations of CO2, pollution levels such as tropospheric ozone, change in climatic variability and extreme events like receding of glaciers in Himalayas.

UNIT-II

Sensors for climate registration and crop monitoring, phytomonitoring and biosensors, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, insect pests, longer growing seasons and shifts in plant hardiness for perennial fruit crops, flowering plants and other plant species.

UNIT-III

Impact of climate changes on invasive insect, disease, weed, pests, horticulture yield, quality and sustainability, climate management in field production – mulching - use of plastic- windbreak- spectral changes- frost protection. Climate management in greenhouse- heating - vents - CO2 injection - screens - artificial light.

UNIT-IV

Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems around the world. Special protected cultivation now and in the future, growth chambers, production in space, biosphere, future aspects of close production, future greenhouse, use of LED as artificial light, future sensor types etc. clean development mechanism, role of tropical trees.

Suggested Readings

- Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency.
- Rao GSLHV, Rao GGSN, Rao VUM & Ramakrishnan YS. 2008. *Climate Change and Agriculture over India*. ICAR.
- Rao GSLHV. 2008. *Agricultural Meteorology*. Prentice Hall.

3. Minor Subject(s)

The student admitted for M.Sc. Ag. Horticulture (Fruit Science) Degree Programmewill study Vegetable Science as the minor subject.

3.1.Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
VSC 501	11060202	PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS	3(2+1)
VSC 502	11060304	PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS	3(2+1)
VSC 505	11060401	SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS	3(2+1)

3.1.1. Course Content

VSC 501/11060202: PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 3(2+1)

Objective

To educate production technology of cool season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT-I

Potato

UNIT-II

Cole crops: cabbage, cauliflower, knolkhol, sprouting broccoli, Brussel's sprout

UNIT-III

Root crops: carrot, radish, turnip and beetroot

UNIT-IV

Bulb crops: onion and garlic

UNIT-V

Peas and broad bean, green leafy cool season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Experiments to demonstrate the role of mineral elements, plant growth substances and herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/ polyhouse.

Suggested Readings

- Bose TK &Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.
- Bose TK, Som G & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.
- Bose TK, Kabir J, Maity TK, Parthasarathy VA &Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
- Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
- Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons.
- Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
- Edmond JB, Musser AM & Andrews FS. 1951. *Fundamentals of Horticulture*. Blakiston Co.
- Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
- Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables:Principles, Production and Nutritive Values*. Chapman & Hall.
- Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.
- Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
- Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.

- Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.
- Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
- Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata McGraw-Hill.

VSC 502/11060304: PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS 3(2+1)

Objective

To teach production technology of warm season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of:

UNIT-I

Tomato, eggplant, hot and sweet peppers

UNIT-II

Okra, beans, cowpea and cluster bean

UNIT-III

Cucurbitaceous crops

UNIT-IV

Tapioca and sweet potato

UNIT-V

Green leafy warm season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments to demonstrate the role of mineral elements, physiological disorders; plant growth substances and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

Suggested Readings

- Bose TK, Kabir J, Maity TK, Parthasarathy VA &Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
- Bose TK, Som MG & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.
- Brown HD & Hutchison CS. *Vegetable Science*. JB Lippincott Co.
- Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
- Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
- Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
- Nayer NM & More TA 1998. *Cucurbits*. Oxford & IBH Publ.
- Palaniswamy& Peter KV. 2007. *Tuber Crops*. New India Publ. Agency.
- Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.

- Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
- Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.
- Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.
- Thamburaj S & Singh N. 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
- Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata Mc Graw Hill.

VSC 505/11060401: SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS3(2+1)

Objective

To educate principles and methods of quality seed and planting material production in vegetable crops.

Theory

UNIT-I

Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India.

UNIT-II

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production.

UNIT-III

Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.

UNIT-IV

Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

UNIT-V

Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

Practical

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; roguing of off-type; methods of hybrid seed production in important vegetable and spice crops; seed extraction techniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

Suggested Readings

- Agrawal PK &Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.
- Agrawal RL. (Ed.). 1997. *Seed Technology*. Oxford & IBH.
- Bendell PE. (Ed.). 1998. *Seed Science and Technology: Indian Forestry Species*. Allied Publ.

- Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.
- George RAT. 1999. *Vegetable Seed Production*. 2nd Ed. CABI.
- Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.
- More TA, Kale PB &Khule BW. 1996. *Vegetable Seed production Technology*. Maharashtra State Seed Corp.
- Rajan S & Baby L Markose. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.
- Singh NP, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distributing Co.
- Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

4. Supporting Courses

4.1. Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
FST455	11060203	EXPERIMENTAL DESIGNS	3(2+1)
PP501	11060107	PRINCIPLES OF PLANT PHYSIOLOGY	4(3+1)
*SOILS 511	11060105	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	2(0+2)

***** Compulsory for students having horticultural crop nutrition related research problem

4.1.1. Course Contents

FST 455/11060203: EXPERIMENTAL DESIGNS 3(2+1)

Objective

This course is meant for students of agricultural and other related sciences. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

UNIT-I

Need for designing of experiments, characteristics of a good design. Basic principles of designs - randomization, replication and local control.

UNIT-II

Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

UNIT-III

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

UNIT-IV

Split plot and strip plot designs; Analysis of covariance and missingplot techniques in randomized block and Latin square designs;Transformations, crossover designs, balanced incomplete block design, Lattice design, Response surfaces.

UNIT-V

Bioassays- direct and indirect, potency estimation.

Practical

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Fitting of response surfaces and Bioassays.

Suggested Readings

- Cochran WG & Cox GM. 1957. *Experimental Designs*. 2nd Ed. John Wiley.
- Dean AM & Voss D. 1999. *Design and Analysis of Experiments*. Springer. Federer WT. 1985. *Experimental Designs*. MacMillan.
- Fisher RA. 1953. *Design and Analysis of Experiments. Oliver & Boyd.*
- Nigam AK & Gupta VK. *1979. Handbook on Analysis of Agricultural Experiments. IASRI Publication*
- Pearce SC. 1983. *The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.*
- Design Resources Server: www.iasri.res.in /design.

PP 501/ 11060107: PRINCIPLES OF PLANT PHYSIOLOGY4 (3+1)

Theory

Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions; cell membrane structure and functions Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology, water potential of plant cells. Mechanism of water uptake by roots-transport in roots, aquaporins, movement of water in plants – Mycorhizal association on water uptake. Water loss from plants-Energy balance-Solar energy input-energy dissipation at crop canopy level- evapotranspiration transpiration –Driving force for transpiration, plant factors influencing transpiration rate. Stomata structure and function – mechanism of stomatal movement, antitranspirants. Physiology of water stress in plants: Influence of water stress at cell, organ, plant and canopy levels. Indices for assessment of drought resistance. The role of mineral nutrients in plant metabolism: Essential elements, classification based on function of elements in plants. Uptake of mineral elements in plants –Mechanisms of uptake-translocation of minerals in plants. Physiological and metabolic functions of mineral elements, critical levels, deficiency symptoms, nutrient deficiency and toxicity. Foliar

nutrition. Photosynthesis and its importance in bio productivity. Photochemical process, photochemical reactions, CO2 reduction in Calvin cycle, supplementary pathway of C fixation in C4 and CAM plants and its significance. Photorespiration and its relevance. Photosynthesis as a diffusive processeffect of environmental factors on photosynthetic rates. Synthesis of sucrose, starch, oligo and polysaccharides (composition of cell wall). Translocation of photosynthates and its importance in sink growth. Secondary metabolites and their significance in plant defence mechanism. Growth and differentiation. Hormonal concept of growth and differentiation, plant growth hormones and their physiological role synthetic growth regulators, growth retardants., Apical dominanace, senescence, fruit growth, abscission. Photo morphogenesis: Photo receptors, phytochrome, cryptochrome, physiology of flowering- Photoperiodism and Vernalisation. Practical Measurement of soil water status: Theory and principle of pressure plate apparatus, neutron probe,

Practical

Measurement of plant water status: Relative water content, water saturation deficits Chardakov's test. Theory and principle of pressure bomb, psychrometer and osmometer, Measurement of transpiration rate. Measurement of vapour pressure deficits, theory and principle of porometry, diffusion prometer and Steady state porometer, Stomatal physiology, influence of ABA on stomatal closing. Mineral nutrients: Demonstration of energy requirement for ion uptake. Deficiency symptoms of nutrients, Radiant energy measurements, separation and quantification of chlorophylls, O2 evolution during photosynthesis, Measurement of gas exchange parameters, conductance, photosynthetic rate, photorespiration, Respiration rates, Estimation of reducing sugars, starch. Estimation of NO3, free aminoacids in the xylem exudates, quantification of soluble proteins. Bioassays for different growth hormones- Auxins, Gibberellins, Cytokinins, ABA and ethylene. Demonstration of photoperiodic response of plants in terms of flowering.

Suggested Readings

- Hopkins WG &Huner NPA. 2004. Introduction to Plant Physiology. John Wiley & Sons.
- Salisbury FB & Ross C. 1992. Plant Physiology. 4th Ed. Wadsworth Publ.
- Taiz L & Zeiger E. 2006. Plant Physiology. 4th Ed. Sinauer Associates.

SOILS511/ 11060105: ANALYTICAL TECHNIQUES AND INSTRUMENTALMETHODS IN SOIL AND PLANT ANALYSIS 2(0+2)

Objective

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Practical

UNIT-I

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

UNIT-II

Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

UNIT-III

Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray refractrometery; identification of minerals by X-ray by different methods.

UNIT-IV

Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

UNIT-V

Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.

UNIT-VI

Determination of lime and gypsum requirement of soil; drawing normalized exchange isotherms; measurement of redox potential.

UNIT-VII

Analysis of soil extracts and irrigation waters for their soluble cations and anions and interpretation of results.

Suggested Readings

- Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons.
- Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
- Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.
- Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.
- Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
- Piper CE. *Soil and Plant Analysis*. Hans Publ.
- Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis - AMethods Manual*. IARI, New Delhi.
- Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.
- Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.
- Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

5. Compulsory Non-Credit Courses

5.1.Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
PGS 501	11060111	LIBRARY AND INFORMATION SERVICES	1(0+1)
PGS 502	11060204	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	1(0+1)
PGS 503	11060205	INTELLECTUAL PROPERTY & ITS MANAGEMENT IN AGRICULTURE (e-	1(1+0)

		Course)	
PGS 504	11060206	BASIC CONCEPTS IN LABORATORY TECHNIQUES	1(0+1)
PGS 505	11060306	AGRICULTURAL RESEARCH, RESEARCH ETHICS & RURAL DEVELOPMENT PROGRAMMES (e-Course)	1(1+0)
PGS 506	11060106	DISASTER MANAGEMENT (e-Course)	1(1+0)

Note: Course content of Compulsory non-credit courses is given in Agronomy Section.

6. E- Resources for Information on Horticulture

1. Agricultural & Processed Food Products Export Development Authority (APEDA) http://www.apeda.com/
2. American Society for Horticultural Science http://www.ashs.org/Asian Vegetable Research and Development Center (AVRDC) http://www.avrdc.org.tw/
3. Australian Society for Horticultural Science http://www.aushs.org.au/
4. Central Food Technological Research Institute (CFTRI) http://www.cftri.com/
5. Central Institute of Medicinal & Aromatic Plants (CIMAP) http://www.cimap.org/
6. Central Institute of Post-harvest Engineering and Technology http://www.icar.org.in/ciphet.html
7. Central Plantation Crops Research Institute (CPCRI), Kasaragod, Kerala http://cpcri.nic.in/
8. Central Tuber Crops Research Institute (CTCRI),Thiruvananthapuram, Kerala http://www.ctcri.org/
9. Consultative Group on International Agricultural Research, CGIAR http://www.cgiar.org/
10. Coffee Board, India http://indiacoffee.org/Department of Agriculture and Co-operation, India http://agricoop.nic.in/
11. Department of Bio-technology, India http://dbtindia.nic.inDepartment of Scientific and Industrial Research, India http://dsir.nic.in/
12. FAO http://www.fao.org/Global Agribusiness Information Network: http://www.fintrac.com/gain/:
13. Greenhouse Vegetable Information: http://www.ghvi.co.nz/
14. Indian Agricultural Research Institute (IARI) http://www.iari.res.in/
15. Indian Council of Agricultural Research (ICAR) http://www.icar.org.in
16. Indian Institute of Horticultural Research (IIHR) www.iihr.res.in
17. Indian Institute of Spices Research (IISR),Calicut, Kerala http://www.iisr.org/
18. Indo-American Hybrid Seeds www.indamseeds.com
19. Institute of Vegetable and Ornamental Crops http://www.igzev.de/
20. Institute for Horticultural Development, Victoria, Australia http://www.nre.vic.gov.au/agvic/ih/
21. Kerala Agricultural University www.kau.edu
22. Iowa State University, Department of Horticulture http://www.hort.iastate.edu/
23. National Bureau of Plant Genetic Resources (NBPGR), India http://nbpgr.delhi.nic.in/
24. National Horticulture Board (NHB), India http://hortibizindia.nic.in/

25. National Institute of Agricultural Extension Management (MANAGE), India http://www.manage.gov.in/
26. National Research Centre for Cashew (NRCC), http://kar.nic.in/cashew/India
27. National Research Centre for Mushroom (NRCM), India http://www.nrcmushroom.com/
28. National Research Centre for Oil Palm (NRCOP), India http://www.ap.nic.in/nrcop
29. North Carolina State University, Dept. of Horticulture http://www2.ncsu.edu/cals/hort_sci/
30. Oregon State University, Dept. of Horticulture http://osu.orst.edu/dept/hort
31. Pineapple News http://agrss.sherman.hawaii.edu/pineapple/pineappl.htm
32. Pomology Resources Center http://www.bsi.fr/pomologie/english/pomology:Rubber board, India http://rubberboard.org.in/
33. Spice Paprika web site http://www.paprika.deltav.hu/:
34. Spices Board, India http://www.indianspices.com/
35. Sri Lanka Agri-business on-line http://www.agro-lanka.org/
36. Sustainable Apple Production: http://orchard.uvm.edu/
37. Tea Board, India http://tea.nic.in/
38. The Horticultural Taxonomy Group http://www.hortax.org.uk/
39. The International Society of Citriculture: http://www.lal.ufl.edu/isc_citrus_homepage.htm
40. The Internet Garden http://www.internetgarden.co.uk/
41. The Rose Resource http://rose.org/
42. The USDA Agricultural Research Service http://www.ars.usda.gov/
43. University of Florida, Dept. of Environmental Horticulture http://hort.ifas.ufl.edu/
44. University of California, Fruit & Nut Research http://fruitsandnuts.ucdavis.edu/
45. US Environmental Protection Agency http://www.epa.gov/:
46. USDA http://www.usda.gov/

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M.Sc. Ag. Horticulture (Vegetable Science)

Contents

1. Executive Summary

Agriculture is the primary source of livelihood for about 58% of India's population. Gross Value Added (GVA) by agriculture, forestry and fishing was estimated at Rs. 19.48 lakh crore (US$ 276.37 billion) in FY20 (PE). Growth in GVA in agriculture and allied sectors stood at 4% in FY20. Horticulture plays a pivotal role in the food, nutrition and livelihood security of India. Though, horticultural crops occupy only 8.5% of arable land, they contribute 24.5% of the GDP in agriculture. Recently published special report of UN on the – 'Right to Food' estimated that nearly one billion people sleep without food across the world, and at every sixth second a child dies of malnutrition. Production of horticulture crops in India was estimated at a record 320.48 million metric tonnes (MMT) in FY20 as per second advance estimates. Plantation crops (tea, coffee and rubber) occupying 0.95% of cropped area have stake of 15.1% in the total export earnings. Horticulture and Plantation sector cover production, post-harvest management, marketing, processing and export of fruits,vegetables, flowers, medicinal and aromatic plants, plantation crops, spices, bamboo,mushroom, apiculture and sericulture. India is among the 15 leading exporters of agricultural products in the world. Agricultural export from India reached US$ 38.54 billion in FY19 and US$ 35.09 billion in FY20. The organic food segment including fruits and vegetables in India is expected to grow at a CAGR of 10% during 2015--25 and is estimated to reach Rs. 75,000 crore (US$ 10.73 billion) by 2025 from Rs. 2,700 crore (US$386.32 million) in 2015. India's performance on the fruit and vegetable production front is laudable but in value addition, processing and export segments the expected goals are not being realized. In spite of having a 10% share in global production of both fruits and vegetables, just 1.8% is processed and our export is a meagre 0.4%.The 11th Plan initiated a massive National Horticulture Mission with an outlay of Rs. 20,000 crores. The Private sector has come up with massive investments in corporate farming, processing and marketing.

The existing single M.Sc. Ag. Horticulture (Fruit Science) programme is quite inadequate to meet the present and future human-resource requirement. The programme needs to be expanded as done in the Syllabus of Horticulture for Agricultural Scientists Recruitment Board (ASRB) Examination. The proposed M.Sc. Ag. Horticulture programmes are:

i). M. Sc. Ag. Horticulture (Fruit Science)
ii). M. Sc. Ag. Horticulture (Vegetable Science)
iii).M. Sc. Ag. Horticulture (Floriculture and Land Scape Architecture)
iv). M. Sc. Ag. Horticulture (Plantation Crops, Spices, Medicinal and Aromatic Crops)

The syllabus in the existing single PG degree programme was expanded to meet the requirements of the four PG Programmes. The basic philosophy behind the revision was to:

i). Increase the basic science content

ii). Update the overall content in view of globalized economy
iii). Imbibe technologies from developed countries
iv). Complywith National and International Law in respect of food quality, standards and specifications
v). Use ICT in Horticulture Education

Keeping pace with the educational reforms, The SGTU has planned to introduce the new programmes in a phased manner and **M.Sc.Ag.Horticulture (Vegetable Science)** is the second addition after already existing M. Sc. Ag. Horticulture (Fruit Science) programme under M.Sc. Ag. Horticulture.

The newly proposed **M.Sc. Ag. Horticulture (Vegetable Science)** programme will be on similar pattern as suggested by ICAR. Core and optional courses for vegetable crops have been included in the syllabus. Production technology, breeding and seed production of crops are covered under core courses. Introduction and history have been avoided from the syllabi as these are already covered at graduate level. Recent advances in biotechnology and protected cultivation, marker-assisted breeding, IPR issues, patenting, organic crop production and GAPareincludedin the syllabus.Production technology of underexploited crops and abiotic stress management has also been considered as relevant topics for PG curriculum. Reference section is enriched with the latest text books on the concerned subjects.

1.1. Organization of Course Contents& Credit Requirements

1.1.1. General Information about Course Code Numbers

i). All courses for M.Sc. Ag. Horticulture (Vegetable Science) will be of 500-series.

ii). Credit seminar has been designated by code no. 591, while code no. 599 pertains for Master'sResearch.

1.1.2. General Information about Course Contents

The contents of each course have been organized into:

i). Objective (s) – to elucidate the basic purpose.

ii). Theory units – to facilitate uniform coverage of syllabus for paper setting.

iii). Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.

iv). E-Resources - This may be useful as study material for research topics/ for quick update on specific topics/events pertaining to the subject.

1.1.3. Minimum Credit Requirement

Subject*	**Master's Programme**
Major	20
Minor	09
Supporting	05
Seminar	01
Research	20

Total Credit	55
Compulsory Non-Credit Courses	Section 5

*****Major subject: The subject (department) in which the student takes admission

Minor subject: The subject closely related to student's major subject.

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.

Compulsory Non-Credit Courses: Please see Section 5 for details. Six courses (PGS 501 to PGS 506) are of general nature and are compulsory for Master's programme.

2. Major Subject Courses

2.1. Courses' Structure at a Glance

Course Code (ICAR pattern)	**Course Code (SGTU pattern)**	**Course Title**	**Credits**
VSC 501*	11060202	PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS	3(2+1)
VSC 502*	11060304	PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS	3(2+1)
VSC 503*	11060212	BREEDING OF VEGETABLE CROPS	3(2+1)
VSC 504*	11060213	GROWTH AND DEVELOPMENT OF VEGETABLE CROPS	3(2+1)
VSC 505	11060401	SEED PRODUCTION TECHNOLOGY OF VEGETABLECROPS	3(2+1)
VSC 506	11060114	SYSTEMATICS OF VEGETABLE CROPS	2(1+1)
VSC 507	11060113	PRODUCTION TECHNOLOGY OF UNDER-EXPLOITED VEGETABLE CROPS	2(1+1)
VSC 508	11060310	ORGANIC VEGETABLE PRODUCTION TECHNOLOGY	2(1+1)
VSC 509	11060309	FUNDAMENTALS OF PROCESSING OF VEGETABLES	2(1+1)
VSC 591	11060405	MASTER'S SEMINAR	1(1+0)
VSC 599	11060406	MASTER'S RESEARCH	20

*** Compulsory Course**

2.2. Course Content

VSC 501/ 11060202: PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 3(2+1)

Objective

To teach production technology of cool season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT I

Potato

UNIT II

Cole crops: cabbage, cauliflower, knol kohl, sprouting broccoli, Brusselssprout

UNIT III

Root crops: carrot, radish, turnip and beetroot

UNIT IV

Bulb crops: onion and garlic

UNIT V

Peas and broad bean, green leafy cool season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation,weed control) of winter vegetable crops and their economics; Experimentsto demonstrate the role of mineral elements, plant growth substances andherbicides; study of physiological disorders; preparation of croppingscheme for commercial farms; visit to commercial green-house/ poly-house.

Suggested Readings:

- Bose TK &Som MG. (Eds.). 1986. Vegetable Crops in India. NayaProkash.
- Bose TK, Som G & Kabir J. (Eds.). 2002. Vegetable Crops. Naya Prokash.
- Bose TK, Som MG & Kabir J. (Eds.). 1993. Vegetable Crops. NayaProkash.
- Bose TK, Kabir J, Maity TK, Parthasarathy VA &Som MG. 2003.Vegetable Crops. Vols. I-III. Naya Udyog.
- Chadha KL &Kalloo G. (Eds.). 1993-94. Advances in Horticulture Vols.V-X. Malhotra Publ. House.
- Chadha KL. (Ed.). 2002. Hand Book of Horticulture. ICAR.
- Chauhan DVS. (Ed.). 1986. Vegetable Production in India. Ram Prasad &Sons.

- Decoteau DR. 2000. Vegetable Crops. Prentice Hall.
- Edmond JB, Musser AM & Andrews FS. 1951. Fundamentals of Horticulture. Blakiston Co.
- Fageria MS, Choudhary BR & Dhaka RS. 2000. Vegetable Crops: Production Technology. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. Vegetable Crops. New India Publ. Agency.
- Hazra P &Som MG. (Eds.). 1999. Technology for Vegetable Production
- and Improvement. Naya Prokash.
- Rana MK. 2008. Olericulture in India. Kalyani Publ.
- Rana MK. 2008. Scientific Cultivation of Vegetables. Kalyani Publ.
- Rubatzky VE & Yamaguchi M. (Eds.). 1997. World Vegetables: Principles, Production and Nutritive Values. Chapman & Hall.
- Saini GS. 2001. A Text Book of Oleri and Flori Culture. Aman Publ. House.
- Salunkhe DK & Kadam SS. (Ed.). 1998. Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing. Marcel Dekker.
- Shanmugavelu KG. 1989. Production Technology of Vegetable Crops. Oxford & IBH.
- Singh DK. 2007. Modern Vegetable Varieties and Production Technology. International Book Distributing Co.
- Singh SP. (Ed.). 1989. Production Technology of Vegetable Crops. Agril. Comm. Res. Centre.
- Thamburaj S & Singh N. (Eds.). 2004. Vegetables, Tuber Crops and Spices. ICAR.
- Thompson HC & Kelly WC. (Eds.). 1978. Vegetable Crops. Tata McGrawHill.

VSC 502/ 11060304: PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS 3(2+1)

Objective

To teach production technology of warm season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures, economics of crop production and seed production of:

UNIT I

Tomato, eggplant, hot and sweet peppers

UNIT II

Okra, beans, cowpea and cluster-bean

UNIT III

Cucurbitaceous crops

UNIT IV

Tapioca and sweet potato

UNIT V

Green leafy warm season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments to demonstrate the role of mineral elements, physiological disorders; plant growth substances and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

Suggested Readings

- Bose TK &Som MG. (Eds.). 1986. Vegetable Crops in India. Naya Prokash.
- Bose TK, Kabir J, Maity TK, Parthasarathy VA &Som MG. 2003.Vegetable Crops. Vols. I-III. Naya Udyog.
- Bose TK, Som MG & Kabir J. (Eds.). 2002. Vegetable Crops. Naya Prokash.Brown HD & Hutchison CS. Vegetable Science. JB Lippincott Co.
- Chadha KL &Kalloo G. (Eds.). 1993-94. Advances in Horticulture. Vols. V-X. Malhotra Publ. House.
- Chadha KL. (Ed.). 2002. Hand Book of Horticulture. ICAR.
- Chauhan DVS. (Ed.). 1986. Vegetable Production in India. Ram Prasad & Sons.
- Decoteau DR. 2000. Vegetable Crops. Prentice Hall.
- Edmond JB, Musser AM & Andrews FS. 1964. Fundamentals of Horticulture. Blakiston Co
- Fageria MS, Choudhary BR & Dhaka RS. 2000. Vegetable Crops: Production Technology. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. Vegetable Crops. New India Publ. Agency.
- Hazra P &Som MG. (Eds.). 1999. Technology for Vegetable Production and Improvement. Naya Prokash.
- Kalloo G & Singh K (Ed.). 2000. Emerging Scenario in Vegetable Research and Development. Research Periodicals & Book Publ. House.
- Nayer NM & More TA 1998. Cucurbits. Oxford & IBH Publ.
- Palaniswamy& Peter KV. 2007. Tuber Crops. New India Publ. Agency.
- Pandey AK &Mudranalay V. (Eds.). Vegetable Production in India: Important Varieties and Development Techniques.
- Rana MK. 2008. Olericulture in India. Kalyani.
- Rana MK. 2008. Scientific Cultivation of Vegetables. Kalyani.
- Rubatzky VE & Yamaguchi M. (Eds.). 1997. World Vegetables:Principles, Production and Nutritive Values. Chapman & Hall.
- Saini GS. 2001. A Text Book of Oleri and Flori Culture. Aman Publ. House.
- Salunkhe DK & Kadam SS. (Ed.). 1998. Hand Book of Vegetable Scienceand Technology: Production, Composition, Storage and Processing. Marcel Dekker.Shanmugavelu KG. 1989. Production Technology of Vegetable Crops.Oxford & IBH.

VSC503/11060212: BREEDING OF VEGETABLE CROPS3(2+1)

Objective

To educate students regarding principles and practices adopted for breeding of vegetablecrops.

Theory

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives,breeding methods (introduction, selection, hybridization, mutation),varieties and varietal characterization, resistance breeding for biotic andabiotic stress, quality improvement, molecular marker, genomics, markerassisted breeding and QTLs, biotechnology and their use in breeding invegetable crops-Issue of patenting, PPVFR act.

UNIT I

Potato and tomato

UNIT II

Eggplant, hot pepper, sweet pepper and okra

UNIT III

Peas and beans, amaranth, chenopods and lettuce

UNIT IV

Gourds, melons, pumpkins and squashes

UNIT V

Cabbage, cauliflower, carrot, beetroot, radish, sweet potato and tapioca

Practical

Selection of desirable plants from breeding population observations andanalysis of various qualitative and quantitative traits in germplasm, hybridsand segregating generations; induction of flowering, palanological studies,selfing and crossing techniques in vegetable crops; hybrid seed productionof vegetable crops in bulk. screening techniques for insect-pests, diseaseand environmental stress resistance in above mentioned crops,demonstration of sib-mating and mixed population; molecular- markertechniques to identify useful traits in the vegetable crops and specialbreeding techniques. Visit to breeding blocks.

Suggested Readings:

- Allard RW. 1999. Principles of Plant Breeding. John Wiley & Sons.
- Basset MJ. (Ed.). 1986. Breeding Vegetable Crops. AVI Publ.
- Dhillon BS, Tyagi RK, Saxena S. & Randhawa GJ. 2005. Plant Genetic
- Resources: Horticultural Crops. Narosa Publ. House.
- Fageria MS, Arya PS & Choudhary AK. 2000. Vegetable Crops: Breedingand Seed Production. Vol. I. Kalyani.
- Gardner EJ. 1975. Principles of Genetics. John Wiley & Sons.
- Hayes HK, Immer FR & Smith DC. 1955. Methods of Plant Breeding.McGraw-Hill.
- Hayward MD, Bosemark NO &Romagosa I. (Eds.). 1993. Plant BreedingPrinciples and Prospects. Chapman & Hall.
- Kalloo G. 1988. Vegetable Breeding. Vols. I-III. CRC Press.
- Kalloo G. 1998. Vegetable Breeding. Vols. I-III (Combined Ed.). PanimaEdu. Book Agency.

- Kumar JC & Dhaliwal MS. 1990. Techniques of Developing Hybrids inVegetable Crops. Agro Botanical Publ.
- Paroda RS &Kalloo G. (Eds.). 1995. Vegetable Research with Special
- Reference to Hybrid Technology in Asia-Pacific Region. FAO.
- Peter KV &PradeepKumar T. 2008. Genetics and Breeding of Vegetables.Revised, ICAR.
- Rai N & Rai M. 2006. Heterosis Breeding in Vegetable Crops. New IndiaPubl. Agency.
- Ram HH. 1998. Vegetable Breeding: Principles and Practices. Kalyani.Simmonds NW. 1978. Principles of Crop Improvement. Longman.
- Singh BD. 1983. Plant Breeding. Kalyani.
- Singh PK, Dasgupta SK & Tripathi SK. 2004. Hybrid VegetableDevelopment. International Book Distributing Co.
- Swarup V. 1976. Breeding Procedure for Cross-pollinated VegetableCrops. ICAR.

VSC504/110602013: GROWTH AND DEVELOPMENT OF VEGETABLE CROPS 3 (2+1)

Objective

To teach the physiology of growth and development of vegetable crops.

Theory

UNIT I

Cellular structures and their functions; definition of growth anddevelopment, growth analysis and its importance in vegetable production.

UNIT II

Physiology of dormancy and germination of vegetable seeds, tubers andbulbs; Role of auxins, gibberellins, cytokinin and abscisic acid;Application of synthetic hormones, plant growth retardants and inhibitorsfor various purposes in vegetable crops; Role and mode of action ofmorphactins, anti-tran spirants, anti-auxin, ripening retardant and plantstimulants in vegetable crop production.

UNIT III

Role of light, temperature and photoperiod on growth, development ofunderground parts, flowering and sex expression in vegetable crops; apicaldominance.

UNIT IV

Physiology of fruit set, fruit development, fruit growth, flower and fruitdrop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors,senescence and abscission; fruit ripening and physiological changesassociated with ripening.

UNIT V

Plant growth regulators in relation to vegetable production; morphogenesisand tissue culture techniques in vegetable crops.

Practical

Preparation of solutions of plant growth substances and their application;experiments in breaking and induction of dormancy by chemicals;induction of parthenocarpy and fruit ripening; application of plant growthsubstances for improving flower initiation, changing sex expression incucurbits and

checking flower and fruit drops and improving fruit set insolanaceous vegetables; growth analysis techniques in vegetable crops.

Suggested Readings

- Bleasdale JKA. 1984. Plant Physiology in Relation to Horticulture. 2nd Ed.MacMillan.
- Gupta US. (Ed.). 1978. Crop Physiology. Oxford & IBH.
- Krishnamoorti HN. 1981. Application Plant Growth Substances and TheirUses in Agriculture. Tata-McGraw Hill.
- Peter KV. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency.
- Saini RS, Sharma KD, Dhankhar OP & Kaushik RA. (Eds.). 2001.Laboratory Manual of Analytical Techniques in Horticulture.Agrobios.
- Wien HC. (Ed.). 1997. The Physiology of Vegetable Crops. CABI.

VSC505/ 11060401: SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS3(2+1)

Objective

To educate students regarding principles and methods of quality seed and planting materialproduction in vegetable crops.

Theory

UNIT I

Definition of seed and its quality, new seed policies; DUS test, scope ofvegetable seed industry in India.

UNIT II

Genetical and agronomical principles of seed production; methods of seedproduction; use of growth regulators and chemicals in vegetable seedproduction; floral biology, pollination, breeding behaviour, seeddevelopment and maturation; methods of hybrid seed production.

UNIT III

Categories of seed; maintenance of nucleus, foundation and certified seed;seed certification, seed standards; seed act and law enforcement, plantquarantine and quality control.

UNIT IV

Physiological maturity, seed harvesting, extraction, curing, drying, grading,seed processing, seed coating and pelleting, packaging (containers/packets),storage and cryopreservation of seeds, synthetic seed technology.

UNIT V

Agro-techniques for seed production in solanaceous vegetables, cucurbits,leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra,vegetatively propagated vegetables.

Practical

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour,physical purity) and seed health testing; testing, releasing and notificationprocedures of varieties; floral biology; rouging of

off-types; methods ofhybrid seed production in important vegetable and spice crops; seedextraction techniques; handling of seed processing and seed testingequipment; seed sampling; testing of vegetable seeds for seed purity,germination, vigour and health; visit to seed processing units, seed testinglaboratoryand seed production farms.

Suggested Readings:

- Agrawal PK &Dadlani M. (Eds.). 1992. Techniques in Seed Science andTechnology. South Asian Publ.
- Agrawal RL. (Ed.). 1997**.** Seed Technology. Oxford & IBH.
- Bendell PE. (Ed.). 1998. Seed Science and Technology: Indian ForestrySpecies. Allied Publ.
- Fageria MS, Arya PS & Choudhary AK. 2000. Vegetable Crops: Breedingand Seed Production. Vol. I. Kalyani.
- George RAT. 1999. Vegetable Seed Production. 2nd Ed. CABI.
- Kumar JC & Dhaliwal MS. 1990. Techniques of Developing Hybrids inVegetable Crops. Agro Botanical Publ.
- More TA, Kale PB &Khule BW. 1996. Vegetable Seed ProductionTechnology. Maharashtra State Seed Corp.
- Rajan S & Baby L Markose. 2007. Propagation of Horticultural Crops.New India Publ. Agency.
- Singh NP, Singh DK, Singh YK & Kumar V. 2006. Vegetable SeedProduction Technology. International Book Distributing Co.
- Singh SP. 2001. Seed Production of Commercial Vegetables. AgrotechPubl. Academy.

VSC 506/11060114: SYSTEMATICS OF VEGETABLE CROPS 2(1+1)

Objective

To teach morphological, cytological and molecular taxonomy of vegetable crops.

Theory

UNIT I

Principles of classification; different methods of classification; salientfeatures of international code of nomenclature of vegetable crops.

UNIT II

Origin, history, evolution and distribution of vegetable crops, botanicaldescription of families, genera and species covering various tropical,subtropical and temperate vegetables.

UNIT III

Cytological level of various vegetable crops; descriptive keys for importantvegetables.

UNIT IV

Importance of molecular markers in evolution of vegetable crops;molecular-markers as an aid in characterization and taxonomy of vegetable crops.

Practical

Identification, description, classification and maintenance of vegetable species and varieties; survey, collection of allied species and genera locally available; preparation of keys to the species and varieties; methods of preparation of herbarium and specimens.

Suggested Readings

- Dutta AC. 1986. A Class Book of Botany. Oxford Univ. Press.
- Pandey BP. 1999. Taxonomy of Angiosperm. S. Chand & Co.
- Peter KV &Pradeep Kumar T. 2008. Genetics and Breeding of Vegetables(Revised), ICAR.
- Soule J. 1985. Glossary for Horticultural Crops. John Wiley & Sons.
- Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS.2001. Minimal Descriptors of Agri-Horticultural Crops. Part-II:Vegetable Crops. NBPGR, New Delhi.
- Vasistha. 1998. Taxonomy of Angiosperm. Kalyani.
- Vincent ER & Yamaguchi M. 1997. World Vegetables. 2nd Ed. Chapman &Hall.

VSC507/11060113: PRODUCTION TECHNOLOGY OF UNDER-EXPLOITEDVEGETABLE CROPS 2(1+1)

Objective

To educate students regarding production technology of under-utilized vegetable crops.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT I

Asparagus, artichoke and leek

UNIT II

Brussels's sprout, Chinese cabbage, broccoli, kale and artichoke.

UNIT III

Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu(chenopods) and chekurmanis.

UNIT IV

Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jackbean and sword bean.

UNIT V

Sweet gourd, spine gourd, pointed gourd, Oriental pickling melon and littlegourd (kundru).

Practical

Identification of seeds; botanical description of plants; layout and planting;cultural practices; short-term experiments of under-exploited vegetables.

Suggested Readings:

- Bhat KL. 2001. Minor Vegetables - Untapped Potential. Kalyani.
- lndira P & Peter KV. 1984. Unexploited Tropical Vegetables. KeralaAgricultural University,Kerala.

- Peter KV. (Ed.). 2007-08. Underutilized and Underexploited Horticultural Crops. Vols. I-IV. New India Publ. Agency.
- Rubatzky VE & Yamaguchi M. (Eds.). 1997. World Vegetables:Principles, Production and Nutritive Values. Chapman & Hall
- Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS.2001. Minimal Descriptors of Agri-Horticultural Crops. Part-II:Vegetable Crops. NBPGR, New Delhi.

VSC 508/11060310: ORGANIC VEGETABLE PRODUCTIONTECHNOLOGY 2(1+1)

Objective:

To teach principles, concepts and production of organic farming invegetable crop

Theory

UNIT I

Importance, principles, perspective, concept and component of organicproduction of vegetable crops.

UNIT II

Organic production of vegetables crops, viz., solanaceous crops, cucurbits,cole crops, root and tuber crops.

UNIT III

Managing soil fertility, pests and diseases and weed problems in organicfarming system; crop rotation in organic horticulture; processing andquality control for organic foods.

UNIT IV

Methods for enhancing soil fertility, mulching, raising green manure crops.Indigenous methods of compost, Panchagavvya, Biodynamics, preparationetc. Pest and disease management in organic farming; ITK's in organicfarming. Role of botanicals and bio-control agents.

UNIT V

GAP and GMP- Certification of organic products; organic production andexport - opportunity and challenges.

Practical

Method of preparation of compost, vermicompost, biofertilizers; soilsolarization, bio pesticides in horticulture, green manuring, mycorrhizaeand organic crop production, waste management, organic soil amendmentfor root disease, weed management in organic horticulture. Visit to organicfields and marketing centers.

Suggested Readings

- Dahama AK. 2005. Organic Farming for Sustainable Agriculture. 2nd Ed.Agrobios.
- Gehlot G. 2005. Organic Farming; Standards, Accreditation Certificationand Inspection. Agrobios.

- Palaniappan SP &Annadorai K. 2003. Organic Farming, Theory andPractice. Scientific Publ.
- Pradeep Kumar T, Suma B, Jyothibhaskar&Satheesan KN. 2008.Management of Horticultural Crops. New India Publ. Agency.
- Shivashankar K. 1997. Food Security in Harmony with Nature. 3rd IFOAMASIA, Scientific Conf.. 1- 4 December, 1997, UAS, Bangalore.

VSC 509/11060309: FUNDAMENTALS OF PROCESSING OF VEGETABLES2(1+1)

Objective

To educate students regarding principles and practices of processing of vegetable crops.

Theory

UNIT I

History of food preservation. Present status and future prospects ofvegetable preservation industry in India.

UNIT II

Spoilage of fresh and processed horticultural produce; biochemical changesand enzymes associated with spoilage of horticultural produce; principalspoilage organisms, food poisoning and their control measures. Role ofmicroorganisms in food preservation.

UNIT III

Raw materials for processing. Primary and minimal processing; processingequipment; Layout and establishment of processing industry, FPO license.Importance of hygiene; Plant sanitation.

UNIT IV

Quality assurance and quality control, TQM, GMP. Food standards – FPO,PFA, etc. Food laws and regulations.

UNIT V

Food safety – Hazard analysis and critical control points (HACCP). Labeling and labeling act, nutrition labeling.

UNIT VI

Major value-added products from vegetables. Utilization of byproducts of vegetable processing industry; Management of waste from processing factory.

UNIT VII

Investment analysis. Principles and methods of sensory evaluation of freshand processed vegetables.

Practical

Study of machinery and equipment used in processing of horticultural produce; Chemical analysis for nutritive value of fresh and processed vegetables; Study of different types of spoilages in fresh as well as processed horticultural produce; Classification and identification of spoilage organisms;

Study of biochemical changes and enzymes associated with spoilage; Laboratory examination of vegetable products; Sensory evaluation of fresh and processed vegetables; Study of food standards – National, international, CODEX Alimentarius; Visit to processing units to study the layout, equipment, hygiene, sanitation and residual / waste management.

Suggested Readings:

- Arthey D & Dennis C. 1996. Vegetable Processing. Blackie/Springer Verlag.
- Chadha DS. 2006. The Prevention of Food Adulteration Act. Confed. ofIndian Industry.
- Desrosier NW. 1977. Elements and Technology. AVI Publ. Co.FAO. 1997. Fruit and Vegetable Processing. FAO.
- FAO. CODEX Alimentarius: Joint FAO/WHO Food Standards Programme.2nd Ed. Vol. VB. Tropical Fresh Fruits and Vegetables. FAO.
- FAO. Food Quality and Safety Systems – Training Manual on FoodHygiene and HACCP.
- FAO.Fellow's P. 1988. Food Processing Technology. Ellis HorwoodInternational.
- Frazier WC &Westhoff DC. 1995. Food Microbiology. 4th Ed. TataMcGraw Hill.
- Giridharilal GS, Siddappa & Tandon GL. 1986. Preservation of Fruits andVegetables. ICAR.
- Gisela J. 1985. Sensory Evaluation of Food – Theory and Practices. EllisHorwood.
- Graham HD. 1980. Safety of Foods. AVI Publ. Co.
- Hildegrade H & Lawless HT. 1997. Sensory Evaluation of Food. CBS.Joslyn M & Heid. Food Processing Operations. AVI Publ. Co.
- Mahindru SN. 2004. Food Safety: Concepts and Reality. APH Publ. Corp.
- Ranganna S. 1986. Handbook of Analysis and Quality Control for Fruitand Vegetable Products. 2nd Ed. Tata-McGraw Hill.
- Shapiro R. 1995. Nutrition Labeling Handbook. Marcel Dekker.
- Srivastava RP & Kumar S. 2003. Fruit and Vegetable Preservation:Principles and Practices. 3rd Ed. International Book Distri. Co.
- Tressler& Joslyn MA. 1971. Fruit and Vegetable Juice ProcessingTechnology. AVI Publ. Co.
- Verma LR & Joshi VK. 2000. Post-harvest Technology of Fruits andVegetables: Handling, Processing, Fermentation and WasteManagement. Indus Publ. Co.

3. Minor Subject

The student admitted for M.Sc. Ag. Horticulture (Vegetable Science) will study Fruit Science as the minor subject.

3.1. Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
FSC 501	11060101	TROPICAL AND DRY LAND FRUIT PRODUCTION	3(2+1)
FSC 502	11060102	SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION	3(2+1)
FSC 503	11060201	BIODIVERSITY AND CONSERVATION OF FRUIT CROPS	3(2+1)
FSC 505	11060302	PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS	3(2+1)

FSC 506	11060301	BREEDING OF FRUIT CROPS	3(2+1)
FSC 507	11060103	POST HARVEST TECHNOLOGY FOR FRUIT CROPS	3(2+1)
FSC 512	11060303	GAP FOR HORTICULTURAL CROPS	1(1+0)
FSC 513	11060104	CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION	1(1+0)

3.1.1.Course Contents

FSC 501/11060101: TROPICAL AND DRY LAND FRUIT PRODUCTION 3(2+1)

Objective

To impart basic knowledge about the importance and management of tropical and dry land fruits grown in India.

Theory

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

Crops

UNIT-I

Mango and Banana

UNIT-II

Citrus and Papaya

UNIT-III

Guava, Sapota and Jackfruit

UNIT-IV

Pineapple, Annonas and Avocado

UNIT-V

Ber, Aonla, Bael, Pomegranate, Phalsa, Karonda, Mulberry, Ker, Salvadora, Lasoda and, minor fruits of tropics

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, project preparation for establishing commercial orchards.

Suggested Readings

- Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. Temperate Fruits -Horticulture. Allied Publ.
- Bose TK, Mitra SK & Sanyal D. 2001. (Eds.). Fruits -Tropical and Subtropical. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). Advances in Horticulture. Vols. II–IV, Malhotra Publ. House.
- Nakasone HY & Paul RE. 1998. Tropical Fruits. CABI.
- Peter KV. 2008. (Ed.). Basics of Horticulture. New India Publ. Agency.
- Pradeepkumar T, Suma B, Jyothibhaskar&Satheesan KN. 2008. Management of Horticultural Crops. Parts I, II. New India Publ. Agency.
- Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.
- Singh HP, Negi JP & Samuel JC. (Eds.). 2002. Approaches for Sustainable Development of Horticulture. National Horticultural Board.
- Singh HP, Singh G, Samuel JC & Pathak RK. (Eds.). 2003. Precision Farming in Horticulture. NCPAH, DAC/PFDC, CISH, Lucknow.

FSC 502/11060102: SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 3(2+1)

Objective

To impart basic knowledge about the importance and management of subtropical and temperate fruits grown in India.

Theory

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, biotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones (AEZ) and industrial support.

Crops

UNIT-I

Apple, pear, quince, grapes

UNIT-II

Plums, peach, apricot, cherries, hazelnut

UNIT-III

Litchi, loquat, persimmon, kiwifruit, strawberry

UNIT-IV

Nuts- walnut, almond, pistachio, pecan

UNIT-V

Minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to subtropical and temperate orchards, Project preparation for establishing commercial orchards.

Suggested Readings

- Bose TK, Mitra SK &Sanyol D. (Ed.). 2002. Fruits of India – Tropical and Sub-tropical.3rd Ed. Vols. I, II. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). Advances in Horticulture. Vol. I. Malhotra Publ. House.
- Chadha KL &Shikhamany SD. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.
- Janick J & Moore JN. 1996. Fruit Breeding. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). Fruit Breeding in India. Oxford & IBH.
- Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.
- Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. Advances in Citriculture. Jagmander Book Agency.

FSC 503/11060201: BIODIVERSITY AND CONSERVATION OF FRUIT CROPS 3(2+1)

Objective

Understanding the principles of biodiversity and strategies in germplasm conservation of fruit crops.

Theory

UNIT-I

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.

UNIT-II

Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ.*

UNIT-III

Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

UNIT-IV

Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

UNIT-V

GIS and documentation of local biodiversity, Geographical indication.

Crops

Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard apple, ber, aonla, Malus spp., *Prunus* spp., litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

Practical

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

Suggested Readings

- Frankel OH & Hawkes JG. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.
- Peter KV & Abraham Z. 2007. Biodiversity in Horticultural Crops. Vol.I. Daya Publ. House.
- Peter KV. 2008. Biodiversity of Horticultural Crops. Vol. II. Daya Publ. House.

FSC 505/11060302: PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS 3(2+1)

Objective

Familiarization with principles and practices of propagation and nursery management for fruit crops.

Theory

UNIT-I

Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

UNIT-II

Seed quality, treatment, packing, storage, certification, testing. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

UNIT-III

Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working – Progeny orchard and scion bank.

UNIT-IV

Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.

UNIT-V

Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

Practical

Anatomical studies in rooting of cutting and graft union, construction of propagation structures, study of media and PGR. Hardening – case studies, micropropagation, explant preparation, media

preparation, culturing – *in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening. Visit to TC labs and nurseries.

Suggested Readings

- Hartmann HT & Kester DE. 1989. Plant Propagation – Principles and Practices. Prentice Hall of India.
- Bose TK, Mitra SK & Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash.
- Peter KV. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency. Singh SP. 1989 Mist Propagation. Metropolitan Book Co.
- Rajan S & Baby LM. 2007. Propagation of Horticultural Crops. New India Publ. Agency.
- Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.

FSC 506/11060301: BREEDING OF FRUIT CROPS 3(2+1)

Objective

To impart comprehensive knowledge about the principles and practices of breeding of fruit crops.

Theory

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

Crops

UNIT-I

Mango, banana and pineapple

UNIT-II

Citrus, grapes, guava and sapota

UNIT-III

Jackfruit, papaya, custard apple, aonla, avocado and ber

UNIT-IV

Mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam and nuts

UNIT-V

Apple, pear, plums, peach, apricot, cherries and strawberry

Practical

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

Suggested Readings

- Bose TK, Mitra SK &Sanyol D. (Eds.). 2002. Fruits of India – Tropical and Sub-tropical.3rd Ed. Vols. I, II. Naya Udyog.

- Chadha KL & Pareek OP. 1996. (Eds.). Advances in Horticulture. Vol. I. Malhotra Publ. House.
- Chadha KL &Shikhamany SD. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.
- Janick J & Moore JN. 1996. Fruit Breeding. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). Fruit Breeding in India. Oxford & IBH.
- Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.
- Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. Advances in Citriculture. Jagmander Book Agency.

FSC 507/11060103: POST HARVEST TECHNOLOGY FOR FRUIT CROPS 3(2+1)

Objective

To facilitate deeper understanding on principles and practices of postharvest management of fruit crops.

Theory

UNIT-I

Maturity indices, harvesting practices for specific market requirements, influence of pre- harvest practices, enzymatic and textural changes, respiration, transpiration.

UNIT-II

Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT-III

Treatments prior to shipment, *viz*., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage ventilation, refrigeration, modified atmospheric storage, controlled atmospheric storage, physical injuries and disorders.

UNIT-IV

Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

UNIT-V

Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical

Analyzing maturity stages of commercially important fruit crops, improved packing and storage of important fruit crops, physiological loss in weight of fruits, estimation of transpiration, respiration rate, estimation of quality characteristics in stored fruits, cold chain management visit to cold storage and CA storage units, visit to fruit processing units, project preparation, evaluation of processed fruit products.

Suggested Readings

- Bhutani RC. 2003. Fruit and Vegetable Preservation. Biotech Books.
- Chadha KL & Pareek OP. (Eds.). 1996 Advances in Horticulture. Vol. IV. Malhotra Publ. House.

- Haid NF &Salunkhe SK. 1997. Post Harvest Physiology and Handling of Fruits and Vegetables. Grenada Publ.
- Mitra SK. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CABI.
- Ranganna S. 1997. Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill.
- Sudheer KP & Indira V. 2007. Post Harvest Technology of Horticultural Crops. New India Publ. Agency.
- Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals. CABI.

FSC 512/11060303: GAP FOR HORTICULTURAL CROPS 1(1+0)

Objective

To impart comprehensive knowledge about the principles and practices of Good Agricultural Practises (GAP) for horticultural crops.

Theory

UNIT-I

Genesis of GAP – definition/description, components listed by FAO, frame work.

UNIT-II

Management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection. Identification of ways of improving the productivity profitability, and resource efficiency. harvest and post-harvest handling.

UNIT-III

Animal production, product certification, animal waste management, animal health and welfare, harvest.

UNIT-IV

On farm processing, storage, energy and waste management, human health, welfare, safety, wild life benefits.

UNIT-V

Institutions involved in GAP certification. Indian agencies, EUREPGAP (European Retail Producers Group- Good Agricultural Practices), EUREP etc.

Suggested Readings

- Peter KV. 2008. Basics in Horticulture. New India Publ. Agency.

FSC 513/11060104: CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION 1(1+0)

Objective

To develop understanding about the impact and management of climate in horticultural production.

Theory

UNIT-I

Introduction to climate change. Factors directly connected to climate change, average temperature, change in rainfall amount and patterns, rising atmospheric concentrations of CO2, pollution levels

such as tropospheric ozone, change in climatic variability and extreme events like receding of glaciers in Himalayas.

UNIT-II

Sensors for climate registration and crop monitoring, phytomonitoring and biosensors, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, insect pests, longer growing seasons and shifts in plant hardiness for perennial fruit crops, flowering plants and other plant species.

UNIT-III

Impact of climate changes on invasive insect, disease, weed, pests, horticulture yield, quality and sustainability, climate management in field production – mulching - use of plastic- windbreak- spectral changes- frost protection. Climate management in greenhouse- heating - vents - CO2 injection - screens - artificial light.

UNIT-IV

Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems around the world. Special protected cultivation now and in the future, growth chambers, production in space, biosphere, future aspects of close production, future greenhouse, use of LED as artificial light, future sensor types etc. clean development mechanism, role of tropical trees.

Suggested Readings

- Peter KV. 2008. (Ed.). Basics of Horticulture. New India Publ. Agency.
- Rao GSLHV, Rao GGSN, Rao VUM & Ramakrishnan YS. 2008. Climate Change and Agriculture over India. ICAR.
- Rao GSLHV. 2008. Agricultural Meteorology. Prentice Hall.

4. Basic Supporting Courses

4.1. Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
FST 455	11060203	EXPERIMENTAL DESIGNS	3(2+1)
PP 501	11060107	PRINCIPLES OF PLANT PHYSIOLOGY	4(3+1)
*SOILS 511	11060105	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	2(0+2)

***** Compulsory for students taking research problem related to nutrition requirement of vegetable crops

4.1.1. Course Content

FST 455/ 11060203: EXPERIMENTAL DESIGNS 3(2+1)

Objective

This course is meant for students of agricultural and other related sciences. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to

concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

UNIT I

Need for designing of experiments, characteristics of a good design. Basic principles of designs - randomization, replication and local control.

UNIT II

Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

UNIT III

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

UNIT IV

Split plot and strip plot designs; Analysis of covariance and missingplot techniques in randomized block and Latin square designs;Transformations, crossover designs, balanced incomplete block design, Lattice design, Response surfaces.

UNIT V

Bioassays- direct and indirect, potency estimation.

Practical

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Fitting of response surfaces and Bioassays.

Suggested Readings

- Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
- Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
- Federer WT. 1985. Experimental Designs. MacMillan.
- Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
- Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publication
- Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
- Design Resources Server: www.iasri.res.in /design.

PP 501/11060107: PRINCIPLES OF PLANT PHYSIOLOGY 4(3+1)

Theory

UNIT I

Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions; cell membrane structure and functions Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology,

water potential of plant cells. Mechanism of water uptake by roots-transport in roots, aquaporins, movement of water in plants – Mycorrhizal association on water uptake.

UNIT II

Water loss from plants-Energy balance-Solar energy input-energy dissipation at crop canopy level-evapotranspiration transpiration –Driving force for transpiration, plant factors influencing transpiration rate. Stomata structure and function – mechanism of stomatal movement, anti-transpirants. Physiology of water stress in plants: Influence of water stress at cell, organ, plant and canopy levels. Indices for assessment of drought resistance.

UNIT III

The role of mineral nutrients in plant metabolism: Essential elements, classification based on function of elements in plants. Uptake of mineral elements in plants –Mechanisms of uptake-translocation of minerals in plants. Physiological and metabolic functions of mineral elements, critical levels, deficiency symptoms, nutrient deficiency and toxicity. Foliar nutrition.

UNIT IV

Photosynthesis and its importance in bio productivity. Photochemical process, photochemical reactions, CO2 reduction in Calvin cycle, supplementary pathway of C fixation in C4 and CAM plants and its significance. Photorespiration and its relevance. Photosynthesis as a diffusive processeffect of environmental factors on photosynthetic rates. Synthesis of sucrose, starch, oligo and polysaccharides (composition of cell wall). Translocation of photosynthates and its importance in sink growth. Secondary metabolites and their significance in plant defense mechanism.

UNIT V

Growth and differentiation. Hormonal concept of growth and differentiation, plant growth hormones and their physiological role synthetic growth regulators, growth retardants., Apical dominance, senescence, fruit growth, abscission. Photo morphogenesis: Photo receptors, phytochrome, cryptochrome, physiology of flowering- Photoperiodism and Vernalization. Practical Measurement of soil water status: Theory and principle of pressure plate apparatus, neutron probe,

Practical

Measurement of plant water status: Relative water content, water saturation deficits Chardakov's test. Theory and principle of pressure bomb, psychrometer and osmometer, Measurement of transpiration rate. Measurement of vapour pressure deficits, theory and principle of porometry, diffusion porometer and Steady state porometer, Stomatal physiology, influence of ABA on stomatal closing. Mineral nutrients: Demonstration of energy requirement for ion uptake. Deficiency symptoms of nutrients, Radiant energy measurements, separation and quantification of chlorophylls, O2 evolution during photosynthesis, Measurement of gas exchange parameters, conductance, photosynthetic rate, photorespiration, Respiration rates, Estimation of reducing sugars, starch. Estimation of NO3, free aminoacids in the xylem exudates, quantification of soluble proteins. Bioassays for different growth hormones- Auxins, Gibberellins, Cytokinins, ABA and ethylene. Demonstration of photoperiodic response of plants in terms of flowering.

Suggested Readings

- Hopkins WG &Huner NPA. 2004. Introduction to Plant Physiology.
- John Wiley & Sons. Salisbury FB & Ross C. 1992. Plant Physiology. 4th Ed. Wadsworth Publ.
- Taiz L & Zeiger E. 2006. Plant Physiology. 4th Ed. Sinauer Associates.

SOILS 511/ 11060105: ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS 2(0+2)

Objective

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Practical

UNIT I

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

UNIT II

Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

UNIT III

Principles of visible, ultraviolet and infrared spectro-photometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray refractrometery; identification of minerals by X-ray by different methods.

UNIT IV

Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

UNIT V

Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.

UNIT VI

Determination of lime and gypsum requirement of soil; drawing normalized exchange isotherms; measurement of redox potential.

UNIT VII

Analysis of soil extracts and irrigation waters for their soluble cations and anions and interpretation of results.

Suggested Readings

- Hesse P. 971. Textbook of Soil Chemical Analysis. William Clowes & Sons.
- Jackson ML. 1967. Soil Chemical Analysis. Prentice Hall of India.
- Keith A Smith 1991. Soil Analysis; Modern Instrumental Techniques. Marcel Dekker.

- Kenneth Helrich 1990. Official Methods of Analysis. Association of Official Analytical Chemists.
- Page AL, Miller RH & Keeney DR. 1982. Methods of Soil Analysis. Part II. SSSA, Madison.
- Piper CE. Soil and Plant Analysis. Hans Publ.
- Singh D, Chhonkar PK & Pandey RN. 1999. Soil Plant Water Analysis – A Methods Manual. IARI, New Delhi.
- Tan KH. 2003. Soil Sampling, Preparation and Analysis. CRC Press/Taylor & Francis.
- Tandon HLS. 1993. Methods of Analysis of Soils, Fertilizers and Waters. FDCO, New Delhi.
- Vogel AL. 1979. A Textbook of Quantitative Inorganic Analysis. ELBS Longman.

5. Compulsory Non-Credit Courses

5.2.Courses' Structure at a Glance

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
PGS 501	11060111	LIBRARY AND INFORMATION SERVICES	1(0+1)
PGS 502	11060204	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	1(0+1)
PGS 503	11060205	INTELLECTUAL PROPERTY & ITS MANAGEMENT IN AGRICULTURE (e-Course)	1(1+0)
PGS 504	11060206	BASIC CONCEPTS IN LABORATORY TECHNIQUES	1(0+1)
PGS 505	11060306	AGRICULTURAL RESEARCH, RESEARCH ETHICS & RURAL DEVELOPMENT PROGRAMMES (e-Course)	1(1+0)
PGS 506	11060106	DISASTER MANAGEMENT (e-Course)	1(1+0)

Note: Course content of Compulsory non-credit courses is given in Agronomy Section.

6. Semester-wise Course Structure

6.1.Course Structure: 1st Semester

Course Code	Course Title	Theory +Practical	L	T	P	Credits
11060113	PRODUCTION TECHNOLOGY OF UNDER-EXPLOITED VEGETABLE CROPS	Theory +Practical	1	0	1	2(1+1)
11060114	SYSTEMATICS OF VEGETABLE CROPS	Theory +Practical	1	0	1	2(1+1)
11060101	TROPICAL AND DRY LAND FRUIT PRODUCTION	Theory +Practical	2	0	1	3(2+1)
11060102	SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION	Theory +Practical	2	0	1	3(2+1)

11060103	POST HARVEST TECHNOLOGY FOR FRUIT CROPS	Theory +Practical	2	0	1	3(2+1)
11060104	CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION	Theory	1	0	0	1(1+0)
11060105	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	Practical	0	0	2	2(0+2)
11060106	DISASTER MANAGEMENT (E-Course)	Theory	1	0	0	1(1+0)
11060406	MASTER'S RESEARCH	Practical				
11060107	PRINCIPLES OF PLANT PHYSIOLOGY	Theory +Practical	3	0	1	4(3+1)

6.2. Course Structure: 2nd Semester

Course Code	Course Title	Theory +Practical	L	T	P	Credits
11060212	BREEDING OF VEGETABLE CROPS	Theory +Practical	2	0	1	3(2+1)
11060202	PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS	Theory +Practical	2	0	1	3(2+1)
11060213	GROWTH AND DEVELOPMENT OF VEGETABLE CROPS	Theory +Practical	2	0	1	3(2+1)
11060201	BIODIVERSITY AND CONSERVATION OF FRUIT CROPS	Theory +Practical	2	0	1	3(2+1)
11060203	EXPERIMENTAL DESIGNS	Theory +Practical	2	0	1	3(2+1)
11060204	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	Practical	0	0	1	1(0+1)
11060205	INTELLECTUAL PROPERTY & ITS MANAGEMENT IN AGRICULTURE (E-Course)	Theory	1	0	0	1(1+0)
11060206	BASIC CONCEPTS IN LABORATORY TECHNIQUES	Practical	0	0	1	1(0+1)
11060405	MASTER'S SEMINAR	Theory	1	0	0	1(1+0)
11060406	**MASTER'S RESEARCH	Practical				

6.3. Course Structure: 3rdSemester

Course Code	Course Title	Theory +Practical	L	T	P	Credits
11060304	PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS	Theory +Practical	2	0	1	3(2+1)
11060309	FUNDAMENTALS OF PROCESSING OF	Theory	1	0	1	2(1+1)

	VEGETABLES	+Practical				
11060301	BREEDING OF FRUIT CROPS	Theory +Practical	2	0	1	3(2+1)
11060302	PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS	Theory +Practical	2	0	1	3(2+1)
11060303	GAP FOR HORTICULTURAL CROPS	Theory	1	0	0	1(1+0)
11060310	ORGANIC VEGETABLE PRODUCTION TECHNOLOGY	Theory +Practical	1	0	1	2(1+1)
11060111	LIBRARY AND INFORMATION SERVICES	Practical	0	0	1	1(0+1)
11060306	AGRICULTURAL RESEARCH, RESEARCH ETHICS & RURAL DEVELOPMENT PROGRAMMES (E-Course)	Theory	1	0	0	1(1+0)
11060406	**Master's Research	Practical				

6.4. Course Structure: 4th Semester

Course Code (SGTU pattern)	Course Title	Theory +Practical	L	T	P	Credits
11060401	SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS	Theory +Practical	2	0	1	3(2+1)
11060406	**MASTER'S RESEARCH	Practical				

7. E- Resources for Information on Horticulture

47. Agricultural & Processed Food Products ExportDevelopment Authority (APEDA)http://www.apeda.com/
48. American Society for Horticultural Science http://www.ashs.org/Asian Vegetable Research and DevelopmentCenter (AVRDC)http://www.avrdc.org.tw/
49. Australian Society for Horticultural Science http://www.aushs.org.au/
50. Central Food Technological Research Institute(CFTRI)http://www.cftri.com/
51. Central Institute of Medicinal & Aromatic Plants(CIMAP)http://www.cimap.org/
52. Central Institute of Post-harvest Engineering andTechnologyhttp://www.icar.org.in/ciphet.html
53. Central Plantation Crops Research Institute(CPCRI), Kasaragod, Keralahttp://cpcri.nic.in/
54. Central Tuber Crops Research Institute (CTCRI),Thiruvananthapuram, Keralahttp://www.ctcri.org/
55. Consultative Group on International AgriculturalResearch, CGIARhttp://www.cgiar.org/
56. Coffee Board, India http://indiacoffee.org/Department of Agriculture and Co-operation,Indiahttp://agricoop.nic.in/
57. Department of Bio-technology, India http://dbtindia.nic.inDepartment of Scientific and Industrial Research,Indiahttp://dsir.nic.in/
58. FAO http://www.fao.org/Global Agribusiness Information Network:http://www.fintrac.com/gain/:

59. Greenhouse Vegetable Information: http://www.ghvi.co.nz/
60. Indian Agricultural Research Institute (IARI) http://www.iari.res.in/
61. Indian Council of Agricultural Research (ICAR) http://www.icar.org.in
62. Indian Institute of Horticultural Research (IIHR) www.iihr.res.in
63. Indian Institute of Spices Research (IISR),Calicut, Keralahttp://www.iisr.org/
64. Indo-American Hybrid Seeds www.indamseeds.com
65. Institute of Vegetable and Ornamental Crops http://www.igzev.de/
66. Institute for Horticultural Development, Victoria,Australiahttp://www.nre.vic.gov.au/agvic/ih/
67. Kerala Agricultural University www.kau.edu
68. Iowa State University, Department of Horticulture http://www.hort.iastate.edu/
69. National Bureau of Plant Genetic Resources(NBPGR), Indiahttp://nbpgr.delhi.nic.in/
70. National Horticulture Board (NHB), India http://hortibizindia.nic.in/
71. National Institute of Agricultural ExtensionManagement (MANAGE), Indiahttp://www.manage.gov.in/
72. National Research Centre for Cashew (NRCC), http://kar.nic.in/cashew/India
73. National Research Centre for Mushroom(NRCM), Indiahttp://www.nrcmushroom.com/
74. National Research Centre for Oil Palm (NRCOP),Indiahttp://www.ap.nic.in/nrcop
75. North Carolina State University, Dept. ofHorticulturehttp://www2.ncsu.edu/cals/hort_sci/
76. Oregon State University, Dept. of Horticulture http://osu.orst.edu/dept/hort
77. Pineapple News http://agrss.sherman.hawaii.edu/pineapple/pineappl.htm
78. Pomology Resources Center http://www.bsi.fr/pomologie/english/pomology:Rubber board, India http://rubberboard.org.in/
79. Spice Paprika web site http://www.paprika.deltav.hu/:
80. Spices Board, India http://www.indianspices.com/
81. Sri Lanka Agri-business on-line http://www.agro-lanka.org/
82. Sustainable Apple Production: http://orchard.uvm.edu/
83. Tea Board, India http://tea.nic.in/
84. The Horticultural Taxonomy Group http://www.hortax.org.uk/
85. The International Society of Citriculture: http://www.lal.ufl.edu/isc_citrus_homepage.htm
86. The Internet Garden http://www.internetgarden.co.uk/
87. The Rose Resource http://rose.org/
88. The USDA Agricultural Research Service http://www.ars.usda.gov/
89. University of Florida, Dept. of EnvironmentalHorticulturehttp://hort.ifas.ufl.edu/
90. University of California, Fruit&Nut Research http://fruitsandnuts.ucdavis.edu/
91. US Environmental Protection Agency http://www.epa.gov/:
92. USDA http://www.usda.gov/

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M.Sc. Ag. (Plant Pathology)

Contents

1. Executive Summary

The global population will grow from its current 7.8 billion in 2020 to 9.8 billion in 2050 and global food demand is estimated to increase by at least 50%, but demand for protein rich products may grow even faster. In india also population has been increasing with a compounded annual growth rate of 1.6%. An additional 5.0 to 6.0 mt of foodgrains are required to feed the annually increased population. This becomes a challenging task in the event of reducing factor productivity, depleting natural resources- particularly the water and the climate change. In addition to these factors it is estimated that of the36.5 per cent average total losses, 14.1 per cent are caused by diseases. At the coutry level now in addition to the National Food Security, now great emphasis is being laid on Nutritional Security. Here the importance of horticultural and vegetable crops' come in play. The organic food segment including fruits and vegetables in India is also expected to grow at a CAGR of 10% during 2015-25 .Therefore, the importance of diseses control mechanisms is realized.

The science dealing with plant diseases is referred to as plant pathology or phytopathology.The science of plant pathology is also closely allied with other sciences such as botany, mycology, microbiology, genetics, nematology, bacteriology, horticulture, agronomy, and soil science. Therefore, the role of plant pathology is approaching the central stage as it needs diagnosis, management, forecasting and forewarning, quarantine host-pathogen interactions, pathogen resistance and management, all of which can help enhance yield and quality of field and horticultural crops. This is beneficial not just to farmers, but also to the society at large. Pathologists play a crucial role in management of diseases through chemicals, agronomic practices, and biological control or by means of integrated diseases management.

Keeping pace with the educational reforms, The SGTU has planned to introduce the new programmesin a phased manner and M.Sc. Ag. (Plant Pathology) will be the fourth addition to the list of Master's Degree Programmes planned by the Faculty of Agricultural Sciences at SGTU.

The newly proposed M.Sc. Ag. (Plant Pathology) programme will be on similar pattern as suggested by ICAR. Core and optional courses have been included in the syllabus.

1.1. Organization of Course Contents & Credit Requirements

1.1.1. General Information about Course Code Numbers

i). All courses for M.Sc. Ag. (Plant Pathology) will be of 500-series.

ii). Credit seminar has been designated by code no. 591, while code no. 599 pertains for Master's Research.

1.1.2. General Information about Course Contents

The contents of each course have been organized into:

i). Objective (s) – to elucidate the basic purpose.

ii). Theory units – to facilitate uniform coverage of syllabus for paper setting.

iii). Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.

iv). E-Resources - This may be useful as study material for research topics/ for quick update on specific topics/events pertaining to the subject.

1.1.3. Minimum Credit Requirement

Subject*	Master's Programme
Major	20
Minor	09
Supporting	05
Seminar	01
Research	20
Total Credits	55
Compulsory Non-Credit Courses	Section 5

*****Major subject: The subject (department) in which the student takes admission

Minor subject: The subject closely related to student's major subject.

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.

Compulsory Non-Credit Courses: Please see Section 5for details. Six courses (PGS 501 to PGS 506) are of general nature and are compulsory for Master's programme.

2. Major Subject Courses

2.1. Courses' Structure at a Glance

Course Code	Course Title	Credits
PL PATH 501*/11060115	Introductory Mycology	3(2+1)
PL PATH 502*/11060214	Introductory Plant Virology	3(2+1)
PL PATH 503*/11060116	Introductory Plant Bacteriology	3(2+1)
PL PATH 504*/11060118	Principles of Plant Pathology	3(3+0)
PL PATH 505*/11060119	Detection and Diagnosis of Plant Diseases	2(0+2)
PL PATH 506//11060117	Principles of Plant Disease Management	3(2+1)
PL PATH 510/11060312	Seed Pathology	2(1+1)
PL PATH 511/11060219	Chemicals in Plant Disease Management	3(2+1)
PL PATH 515/11060311	Biocontrol of Plant Diseases	3(2+1)
PL PATH 517/11060314	Mushroom Production	3(2+1)
PL PATH 518/11060215	Epidemiology and Forecasting of Plant Diseases	3(2+1)
NEMA 506/11060315	Nematode Diseases of Crops	3(2+1)
PL PATH 591/11060405	Master's Seminar	1(1+0)

***** Compulsory Course

2.1.1. Course Content

PL PATH 501/11060115: Introductory Mycology 3(2+1)

Objective

To study the nomenclature, classification and characters of fungi.

Theory

UNIT-1

Historical introduction to Mycology, definition of different terms, basic concepts.

UNIT-2

Importance of Mycology in Agriculture, relation of fungi to human affairs, history of mycology. Morphology of reproductive structures and conidiogenous cells, Spore types, Saccardo's spore grid, groups and its taxonomic bearing, Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi.

UNIT-3

Classification of fungi. Economic mycology, edible fungi and entomogenous fungi. Mycorrhizal associations. Cell organelles, their morphology, functions and chemical composition.

UNIT-4

The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: (a) Myxomycota and (b) Eumycota- i) Mastigomycotina ii) Zygomycotina, iii) Ascomycotina, iv) Basidiomycotina, v) Deuteromycotina. Lichens types and importance, fungal genetics and variability in fungi

Practical

Detailed comparative study of different groups of fungi; collection, identification and preservation of specimens. Isolation and identification of plant pathogenic fungi.

Suggested Readings

1. Agrios, G.N. 2004. Plant Pathology. Fifth Edition, Academic Press,USA.
2. Alexopoulos, J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology (Fourth Edition), J. Wiley & Sons, NewYork.
3. Mehrotra, R.S. and Aneja, K.R.1998. An Introduction to Mycology. New Age International, NewDelhi.
4. Nagamani, Kunwar and Manoharchary. 2006. Handbook of soil fungi. IK International Pvt. Ltd., NewDelhi.
5. Singh, R.S. 1984. Introduction to Principles of Plant Pathology, Oxford and IBH Publishing Co Pvt. Ltd., NewDelhi.

PL PATH 502/11060214: Introductory Plant Virology 3(2+1)

Objective

To acquaint with the structure, virus-vector relationship, biology and management of plant viruses.

Theory

Unit-1

History of plant viruses, composition and structure of viruses, Virus nomenclature and classification, Structure of plant virus, genome organization, replication and movement of viruses.

Unit-2

Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host virus interaction, virus vector relationship.

Unit-3

Isolation and purification, estimation of virus titre and purity, electron microscopy, protein and nucleic acid-based diagnostics. Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions.

Unit-4

Assay of plant viruses including biological, physical, chemical, serological and molecular methods. Conventional and biotechnological techniques used in detection and diagnosis. Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

Practical

Study of symptoms caused by viruses, transmission, assay of viruses, physical properties, purification, method of raising antisera, serological tests, electron microscopy, spectrophotometry and ultratomy, PCR, preservation of virus specimens, preparation of herbarium.

Suggested Readings

1. Agrios, G.N. 2004. Plant Pathology. Fifth Edition, Academic press,USA
2. Boss, L. 1999. Plant Viruses, Unique and Intriguing pathogens, a text book of plant virology. Backhuys Publishers, Leiden, TheNetherlands
3. Roger, Hull. 2002. Matthews' Plant Virology. Fourth Edition, Academic press,USA
4. Walky, D.G.A. 1985. Applied Plant Virology. Longman, London,UK
5. Kolte, SJ and Tewari, AK.2011.The Elements of Plant Virology - Basic Concepts and Practical Class Exercises, Kalyani Publishers, India,pp340

PL PATH 503/11060116: Introductory Plant Bacteriology 3(2+1)

Objective

To acquaint with plant pathogenic prokaryote (procarya) and theirstructure, nutritional requirements, survival and dissemination.

Theory

Unit-1

History of bacteriology, nomenclature and classification of bacteria, bacteriophages- morphology, types and uses, mycoplasma and bdellovibrios. Bacterial cell-morphology, organelles and their

functions, cell wall structure and chemistry, endospore and its formation, composition and function, flagellar structure, arrangements.

Unit-2

Growth curve, nutrition and auxotrophic mutants, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya. Biology of extra chromosomal elements: plasmid borne genes and their expression: *avr, her, vie* and *pat* genes,

Unit-3

Elementary bacterial genetics and variability: conjugation, transduction and transformation, survival and dissemination of bacteria. Bacteriophages: lytic and lysogenic cycles. Prokaryotic inhibitors and their mode of action. Morphology, biochemical characteristics, reproduction and life cycle of phytoplasma and other fastidiousprokaryotes.

Unit-4

Important bacterial diseases: Bacterial leaf blight of rice, bacterial blight of pomegranate, cotton bacterial blight, bacterial wilt of solanaceous vegetables, soft rot of vegetables and black rot of crucifers and their management

Practical

Isolation, purification, identification and host inoculation of phytopathogenic bacteria, staining methods, biochemical and serological characterization, isolation of plasmid and use of antibacterial chemicals/antibiotics

Suggested Readings

1. Frobisher, M. 1944. Fundamentals of Bacteriology, W. B. SaunersCompany.
2. Gerhardt, P., Murray, R.G.E., Wood, A.W. and Krieg, N.R. 1994. Methods for Molecular Bacteriology, American Society of Microbiology, Washington,DC
3. Jackson, R.W. 2009. Plant Pathogenic Bacteria: Genomics and Molecular Biology, Caister Academic Press,USA.
4. Salle, A.J.1967. Fundamental Principles of Bacteriology, Mc Graw-Hill, Inc., NewYork.
5. Schaad, N.W., Jones, J.B. and Chun, W. 2001. Laboratory Guide for Identification of Plant Pathogenic bacteria, APS Press, St. Paul,Minnisota.

PL PATH 504/11060118: Principles of Plant Pathology3(3+0)

Objective

To introduce the subject of Plant Pathology, its concepts and principles.

Theory

Unit-1

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases, disease caused by phanerogamic parasites

Unit-2

Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development, modern detection methods.Physiologic specialization,Factors influencing infection, colonization and development of symptoms.

Unit-3

Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors, induced resistance, altered plant metabolism as affected by plant pathogens.

Unit-4

Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance. Disease management strategies.

Suggested Readings

1. Robert, D.A. and Boothroyd, C.W. 1984. Fundamentals of Plant Pathology (2nd edn), 432pp.
2. Schumann Gail, L. 1991. Plant Diseases: Their Biology and Social Impact. APS Press, USA. 397pp.
3. Singh, R.S. 1984. Introduction to Principles of Plant Pathology, 3rd edition, pp. 534. Oxford & IBH Publishing Co. (P) Ltd., New Delhi, Bombay,Calcutta.
4. Stakman, E.C. and Harrar, J.G. 1957. Principles of Plant Pathology, pp. 581. The Ronald Press Co., NewYork.
5. Strange, R.N. 1993. Plant Disease Control-Towards environmentally accepted methods. Chapmand and Hall 2-6,London.
6. Vidhyasekharan, P. 1993. Principles of Plant Pathology, CBS Publishers & Distributors, Delhi.166pp.

PL PATH 505/11060119: Detection and Diagnosis of Plant Diseases 2(0+2)

Objective

To impart training on various methods/techniques/instruments used in thestudy of plant diseases/pathogens.

Practical

Laboratory Equipment and their use -Autoclave, hot air oven, laminar air flow, pH meter, spectrophotometer micro tomes and B.O.D. Incubator, Determination. of pH.Field experiments, and collection of data and references.Preparation and sterilization of common media. cleaning and sterilization of glassware and culture media (natural, semi synthetic and synthetic).Inoculation and isolation of pathogens, purification of fungal culture, Koch's postulates. Methods of spore germination, Microscopy: Calibration and measurement of spore, camera Iucida drawing, microtomes and microtomy procedures (paraffin embedding and freeze microtome), Preparation of mount, preservation of fungi, Demonstration of appresoria and houstoriain plant pathogenic fungi. Stains and staining, detection of plant pathogens. In vitro evaluation of fungicides and bactricides. Molecular detection of pathogens in seeds and other planting materials.

Suggested Readings

1. Vishunawat, K and Kolte, SJ. 2001. Essentials of Phytopathological Techniques. Kalyani Publishers.,New Delhi, India,260pp.
2. Kolte, SJ and Tewari, AK. 2011. The Elements of Plant Virology - Basic Concepts and Practical Class Exercises. Kalyani Publishers.,New Delhi, India,313pp.

Agrios, G.N. 2004. *Plant Pathology*. Fifth Edition, Academic pr

PL PATH 506/11060117: Principles of Plant Disease Management3(2+1)

Objective

To acquaint with different strategies for management of plant diseases.

Theory

Unit-1

Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases

Unit-2

Disease resistance and molecular approach for disease management.Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.

Unit-3

History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, Nature, properties and mode of action of antifungal, antibacterial and antiviralchemicals

Unit-4

General principles of plant quarantine. Exotic pathogens and pathogens introduced into India. Sanitary and phytosanitary issues under WTO, TRIPS and PRA. Genetic basis of disease resistance and pathogenicity: gene for gene hypothesis; Seed certification

Practical

In vitro and *in vivo* evaluation of chemicals against plant pathogens; ED and MIC values, study of structural details of sprayers and dusters.

Suggested Readings

1. Agrios, G.N. 2004. Plant Pathology. Fifth Edition, Academic Press,USA.
2. Chaube, H.S. and Pundhir, V.S. 2005. Crop Disease and Their Management. Prentice Hall of India Private Limited.
3. Das Gupta, M.K. 1994. Principles of Plant Pathology. Published by AlliedPublishers
4. John, A.L. and Dickinson, C.H. 1998. Plant Pathology and Plant Pathogens. Wiley-

Blackwell.
5. Manners, J.G. 1993. Principles of Plant Pathology. Cambridge University Press,UK.
6. Singh, R.S. 1984. Introduction to Principles of Plant Pathology, Oxford and IBH Publishing Co Pvt. Ltd., NewDelhi.

PL PATH 510/11060312: Seed Pathology 2(1+1)

Objective

To acquaint with seed-borne diseases, their nature, detection, transmission epidemiology, impacts/loses and management.

Theory

Unit-1

History and importance of seed pathology. International seed testing association its role and functions. Morphology and anatomy of seed; Entry points of seed infection. Plant- seed and seed-plant transillission.

Unit-2

Establishment of infection and Course of disease. Environment affecting establishment, seed crop management. Seed treatment, quarantine for seed certification.

Unit-3

Detection of seed borne pathogen. Seed health testing methods. Important seed transmitted disease, their symptoms and disease cycles.

Unit-4

Storage fungi. Impact of storage fungi on stored grains seeds. Factors influencing invasion of stored grain seed by fungi. Management of seed bronepathogens. Production of disease-free seeds and planting materials. Seed certification.

Practical

Seed treatment, Detection of seed borne pathogen. Seed health testing methods. Important seed transmitted disease, their symptoms and disease cycles. Storage fungi. Impact of storage fungi on stored grains seeds. Factors influencing invasion of stored grain seed by fungi. Management of seed bornepathogens.

Suggested Readings

1. Vishunawat K. 2016 Fundamentals of Seed Pathology.Kalyani Publisher, India.Pp26
2. Neergaard. P. 2011.Seed Pathology, SCIENTIFIC Publishers,pp1187
3. Cooke,B.M.,Jones,D.G.andKaye,B.2006.(eds).Atextbook‘TheEpidemiologyofPlant Diseases, Springer, pp 456.
4. Davis, P.M. 1986. Statistics for describing populations. In : Handbook of Sampling methods for Arthropods in Agriculture (eds L. P. Pedigo and Buntin, G. D.) CRC Press, pp.34-53

PL PATH 511/11060219. Chemicals in Plant Disease Management 3(2+1)

Objective

To impart knowledge on the concepts, principles and judicious use of chemicals in plant disease management.

Theory

Unit-1

History and development of chemicals; definition of pesticides and related terms; advantages and disadvantages of chemicals. Classification of chemicals used in plant disease control and their characteristics.

Unit-2

Chemicals in plant disease control, viz., fungicides, bactericides, nematicides, antiviral chemicals and botanicals Formulations, mode of action and application of different fungicides; chemotherapy and phytotoxicity of fungicides

Unit-3

Handling, storage and precautions to be taken while using fungicides; compatibility with other agrochemicals, persistence, cost-benefit ratio, factor affecting fungicides

Unit-4

General account of plant protection appliances; environmental pollution, residues and health hazards, fungicidal resistance in plant pathogens and its management.

Practical

Acquaintance with formulation of different fungicides and plant protection appliances. Formulation of fungicides, bactericides and nematicides; *in vitro* evaluation techniques, preparation of different concentrations of chemicals including botanical pesticides based on active ingredients against pathogens; persistence, compatibility with other agro-chemicals; detection of naturally occurring fungicide resistant mutants of pathogen; methods of application of chemicals

Suggested Readings

1. Farm Chemicals Handbook. (A global guide to crop protection produced yearly with information on all pesticides plus fer tilizers, sources and regulatory information. Available at www.meisterpro.com)
2. Fry, W.E. 1982. Principles of Plant Disease Management. Academic Press, New York,NY
3. Green, M.B. and Spilker, D.A. 1986. Fungicide Chemistry: Advances and Practical Applications (ACS Symposium Series, 304). American Chemical Society, Oxford University Press
4. Hewitt, H.G. 1998. Fungicides in Crop Protection CABI Publishing, CAB International, Oxon, United Kingdom.
5. Hutson, D. and Miyamoto, J. 1999. Fungicidal Activity: Chemical and Biological Approaches to Plant Protection, John Wiley & Sons. NewYork,

PL PATH 515/11060311: Biocontrol of Plant Diseases 3(2+1)

Objective

To study principles and application of ecofriendly and sustainable management strategies of plant diseases.

Theory

Unit-1

Concept of biocontrol definitions, importance, principles of plant disease management with bioagents, history of biocontrol, merits and demerits of biocontrol,Microorganisms antagonistic to plant pathogens in soil, rhizosphere and phyllosphere and their use in the control of plant diseases; soil fungistasis. Plant growth promoting Rhizobacteria.

Unit-2

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

Unit-3

Characterization and evaluation of bioagents, case example of successful bioagents (bacterial and fungal bioformulation), variability and characterization of bioagents important characteristics like competitive saprophytic ability, pesticideresistance.

Unit-4

Commercial production of antagonists, Improvisation, genetic engineering, delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market. Quality control system of biocontrolagents.

Practical

Isolation, characterization and maintenance of antagonists, methods of study of antagonism and antibiosis, application of antagonists against pathogen *in vitro and in vivo* conditions. Study of cfu/g.

Suggested Readings

1. Baker, E.F. and James, R.C. 1982. Biological Control of Plant Pathogens. American PhytopathologicalSociety.
2. Gnanamanickam, S.S. 2002. Biological control of crop Disease. Kuykendall Marel Dekker, INC.
3. Ramanujam, B. and Rabindra, R.J. 2006. Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India. Precision Fototype ServicesBangalore.
4. Singh, S.P. and Hussanini, S.S. 1998. Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds. Precision Fototype ServicesBangalore

PL PATH 517/11060314: Mushroom Production 3(2+1)

Objective

i).To acquaint the students with historical development of mushroom cultivation and present status of mushroom industry in India.

ii). To develop mushroom cultivation skills for entrepreneurial activity.

Theory

Unit-1

Introduction, history and economic importance of mushrooms. Morphology and taxonomy.

Unit 2

Edible and poisonous mushrooms. Cultivation system and farm design, compost and composting, spawn & spawning, Casing materials and. case running.

Unit 3

Cultivation of mushrooms- Agaricus, Pleurotus, Lentinual, Volverella

Unit 4

Diseases of mushrooms, postharvest handling and processing.

Practical

Cultivation techniques of *Agaricus*, *Oyster*, Pleurotus and *Volverella*mushrooms.

Suggested readings

1. Miles P.G and Chang S. 2004. Cultivation, Nutritional Value, Medicinal Effect, and Environmental ImpactCRC Press,480PP
2. Ritti and Singh U. C.2005. Modern Mushroom Cultivation.Agrobios(India).pp244.
3. Parvatha Reddy, P. 2010. Fungal Diseases and Their Management in Horticultural Crops. ScientificPublication.
4. Saharan, G.S. and Metha, N. 2008. Sclerotinia Disease of Crop Plants; Biology, Ecology and Disease Management, Springer.

PL PATH 518/11060215: Epidemiology and Forecasting ofPlantDiseases3(2+1)

Objective

To acquaint students with the principles of epidemiology and its application in disease forecasting.

Theory

Unit-1

Epidemic concept and historical development, pathometry and crop growth stages, epidemic growth and analysis. Common and natural logrithms, function fitting area under disease progress curve and correctionfactors

Unit-2

Inoculum dynamics, population biology of pathogens, temporal spatial variability in plant pathogens.Epidemic analysis and prediction models. Crop loss assessment: critical and multiple point models.

Unit-3

Survey, surveillance and vigilance, crop loss assessment and models.Monocyclic and polycyclic pathogens. Role of environment and meteorological factors in the development of plant diseaseepidemics.

Unit-4

Principles and pre-requisites of forecasting, systems and factors affecting various components of forecasting, some early forecasting, procedures based on weather and inoculum potential, modeling disease growth and disease prediction.

Practical

Measuring diseases, spore dispersal and trapping, weather recording, survey, multiplication of inoculum, computerized data analysis, function fitting, model preparation and validation.

Suggested Readings

1. Campbell, C.L. and Madden, L.V. 1990. Introduction to Plant Disease Epidemiology. John Willey & Sons, NewYork.
2. Cooke, B.M., Jones, D.G. and Kaye, B. 2006. (eds). A textbook 'The Epidemiologyof Plant Diseases, Springer, pp 456.
3. Davis, P.M. 1986. Statistics for describing populations. In : Handbook of Sampling methods for Arthropods in Agriculture (eds L. P. Pedigo and Buntin, G. D.) CRC Press, pp.34-53.
4. Gilligan, C.A. and Kleczkowski, A. 1997. Population dynamics of botanical epidemics involving primary and secondary infection. Phil Trans R Soc London B 352:591-608.

NEMA 506/11060315: Nematode Diseases of Crops 3 (2+1)

Objective

To impart basic knowledge about the causal organism, nature of damage, symptoms and control of nematode diseases of agricultural and horticultural crops.

Theory

Causal organism, distribution, host range, biology, nature of damage, symptoms, interaction with other organisms and management of major diseases caused by important nematodes in differentcrops:

Unit-1

Cereal crops (Rice, wheat, barley, oat, maize, sorghum): Ear-cockle and tundu disease of wheat, molya disease of wheat and barley; rice-root nematode, root-knot and cyst nematodes, ufra and white tip disease of rice; lesion and cyst nematodes of maize and sorghum.

Pulses, oilseeds, Cash, and fibre crops (Pigeon pea, mungbean, cowpea, chickpea, groundnut, castor, soybean, sunflower, sesame, Sugarcane, sugar beet, Cotton, jute): Pigeonpea cyst

nematode, root-knot, reniform nematodes, lesion, lance nematodes, sugar beet cyst and soybean cyst nematode problems.

Unit-2

Vegetable crops (Tomato, brinjal, chillies, carrot, onion, garlic, okra, cucurbits, potato): root- knot disease, reniform nematode, potato cyst nematode; stem and bulb nematode; nematode problems in protected cultivation.

Unit-3

Horticultural and Ornamental crops (Citrus, grapes, peach, strawberry, papaya, mushroom, rose, chrysanthemum, zinnia, gladiolus, tuberose, crossandra, jasmine): root-knot disease, reniform nematode; slow decline of citrus, Nematode problems in mushroom.

Unit-4

Plantation crops & Medicinal and Aromatic plants (Banana, pepper, betelvine, coconut, arecanut, palm, cocoa, tea, coffee, rubber, condiments): burrowing nematode infestation in banana, spices and condiments, root-knot and lesion nematodes of coffee and tea, red ring disease of coconut. pine wilt disease.

Practical

Study of symptoms of cyst, root-knot, lesion, earcockle, citrus, burrowing, reniform, stem and bulb, white tip, mushroom, leaf and bud, golden nematode damage in different crop plants. Visual field diagnosis of nematode problems through study tours.

Suggested Readings

1. Bridge, J. and Starr, J. 2007. Plant Nematodes of Agricultural Importance, Manson Publishing, 128pp. Bridge, John S., and Starr, J. 2007. Plant Nematodes of Agricultural Importance: A Colour Handbook, Wiley February2007.
2. Kenneth, R.H. and Nelson P.E. 1997. Compendium of Chrysanthemum Diseases,APS
3. Parvatha, Reddy. P. 2008. Diseases of Horticultural Crops: Nematode Problems and their Management, Scientific Publishers,380pp.
4. Perry, R N and Moens, M 2006. Plant Nematology, CABI May2006

3. Minor Subject(s)

The student admitted for M.Sc. Ag. (Plant Pathology) will study Entomology as the minor subject.

3.1. Courses' Structure at a Glance

Course Code	Course Title	Credits
ENT 507/11060217	Biological Control of Crop Pests and Weeds	2(1+1)
ENT 510/11060218	Principles of Integrated Pest Management	2(1+1)
ENT 511/11060216	Major Pests of Crops and Their Management	3(1+2)
ENT 519/11060313	Commercial Entomology	2(1+1)

3.1.1 Course Content

ENT 507/11060217: Biological Control of Crop Pests and Weeds 2(1+1)

Objective

To train the students in theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic microorganisms.

Theory

Unit-1

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation.

Unit-2

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects.

Unit-3

Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation.

Unit-4

Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

Practical

Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers; Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

Suggested Readings

1. De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman & Hall, New York.
2. Dhaliwal GS & Arora R. 2001. Integrated Pest Management: Concepts and Approaches. Kalyani Publ., New Delhi.
3. Huffaker CB & Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London.
4. Ignacimuthu SS &Jayaraj S. 2003. Biological Control of Insect Pests. Phoenix Publ., New Delhi.
5. Saxena AB. 2003. Biological Control of Insect Pests. Anmol Publ., New Delhi.
6. Driesche& Bellows TS. Jr. 1996. Biological Control. Chapman & Hall, New York.

ENT 510/11060218: Principles of Integrated Pest Management 2(1+1)

Objective

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM**.** Train students in computation of ETL, implementing IPM programmes.

Theory

Unit-1

History and origin, definition and evolution of various related terminologies.

Unit-2

Concept and philosophy, ecological principles, economic threshold concept, and economic consideration.

Unit-3

Tools of pest management and their integration- legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys.

Unit-4

Political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.

Practical

Characterization of agro-ecosystems. Sampling methods and factors affecting sampling. Population estimation methods. Crop loss assessmentdirect losses, indirect losses, potential losses, avoidable losses, unavoidable losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system.

Suggested Readings

1. Dhaliwal GS & Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publ., New Delhi.
2. Dhaliwal GS, Singh R &Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publ., New Delhi.
3. Flint MC & Bosch RV. 1981. Introduction to Integrated Pest Management.
4. 1st Ed., Springer, New York.
5. Horowitz AR &Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi.
6. Ignacimuthu SS &Jayaraj S. 2007. Biotechnology and Insect Pest Management. Elite Publ., New Delhi.
7. Metcalf RL & Luckman WH. 1982. Introduction of Insect Pest Management. John Wiley & Sons, New York.
8. Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi.
9. Norris RF, Caswell-Chen EP & Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi.
10. Subramanyam B &Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York.

ENT 511/11060216: Major Pests of Crops and Their Management 3(1+2)

Objective

To familiarize the students about nature of damage and seasonal incidence of insect pests that cause loss to major field crops and their effective management by different methods.

Theory

Unit-1

Introduction to Entomology: Position of insects in animal kingdom and brief history of Entomology in India; non-insect pests and pollinators.

Unit-2

Insect Pests of important crops and their management: Cereals: Paddy, barley, wheat, sorghum, and maize. Pulses: Pigeon pea, chickpea, mung bean, cowpea, and lentil. Oil seeds: Mustard, groundnut, castor, and jatropha. Vegetables: Cole crops, okra, cucurbits, potato, garden peas, and spinach. Fruits: Mango, guava, banana, citrus, ber, and aonla. Cotton. Sugarcane.

Unit-3

Pests of storage and their management: Beetle insects, moth insects, mites, fungi, birds, and rodents.

Unit-4

Pesticide application appliances and their safe handling: Sprayers, dusters and miscellaneous equipments.

Practical

Study of grasshoppers, study of garden slug and its stages, study of Termitarium, termite soldier and workers, distinguishing characters between insect and mite, study of damage symptoms caused by common grasshoppers and birds, study of rodent burrows and identification of live burrows, preparation of rat baits and its application in the live burrows. Study of pesticide labels for toxicity and safe handling, pesticide application equipments - sprayer, duster etc. Study of soil inhabiting pests (cutworms, white grubs, black ants, and nematodes). Study of insect trap, light trap, sticky trap, pheromone trap, and rat trap. Collection and study of insects from pulses, paddy, cotton, vegetables, cereals, oil seeds, fruits, and storage. Calculation of pesticide doses and preparation of stock solution. Study of useful insects (parasites, predators, and pollinators).

Suggested Readings

1. Saxena RC & Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Jodhpur.
2. Atwal AS & Dhaliwal GS. 2002. Agricultural Pests of South Asia and their Management. Kalyani Publ., New Delhi.
3. Nair, M.R.G.K.1986. Insect and Mites of Crops in India. ICAR, New Delhi. Pradhan, S. 1969. Insect Pests of Crops. National Book Trust, India, 208p.
4. Regupathy, A.N., Chandramohan, S., Palanisamy and Gunathilagaraj, K. 2003. A Guide on Crop Pests. TNAU, Coimbatore, 276.

ENT 519/11060313: Commercial Entomology 2(1+1)

Objective

To familiarize the students with entrepreneurial opportunities in entomology, provide information on productive insects and their products, as well as insect pests of public health and veterinary importance and their management.

Theory

Unit-1

Bee keeping- General colony management during different seasons. Seasonal management. Managing colonies for honey production and pollination. Artificial queen rearing. Pests and diseases of honey bees. Bee poisoning. Production and marketing of quality honey and value added honey products. Establishment and maintenance of apiaries.

Unit-2

Study of different species of silkworms, characteristic features, moriculture, silk and its uses, pests and diseases of silkworms, rearing and management of silkworms. Lac insect- natural enemies and their management.

Unit-3

Economic and public health importance of insect pests in human habitation and habitats, biology, damage and control of mosquitoes, houseflies, bed bugs, ants, termites, cockroaches, flies, silverfish, head and body lice, carpet beetles, cloth moths, crickets, wasps, house dust mites, insect pests of cattle, poultry, pet animals and their management.

Unit-4

Principles and methods of pest management in residential places and public buildings, insecticides for domestic use and their safety, pre- and postconstruction termite proofing of buildings, appliances for domestic pest control. Rodent control methods. Organic methods of domestic pest management.

Practical

Assessing pest status in dwellings (labs, canteen or hostel), implementation of pest control against flies, mosquitoes, bed bugs, cockroaches and rodents. Pre- and post-construction termite proofing methods, control of silverfishes in the library. Visit to poultry units and assessing pest status in poultries. Evaluation of commercially available domestic insect pestcontrol products through bioassays. Identification of honey bee species, bee castes and special adaptations, identification and handling of bee-keeping equipments. Handling of honey bees-hive and frame inspection. Honey extraction and processing methods of hive products extraction. Preparation of bee-keeping projects for funding. Visit to bee nursery andcommercial apiaries. Silkworm rearing and management. Lac host and crop management technology and processing of lac. Products and bye-products of lac.

Suggested Readings

1. Aruga H. 1994. Principles of Sericulture. Oxford & IBH, New Delhi. Atwal AS. 2006. The World of the Honey Bee. Kalyani Publ., New Delhi. Ganga G. 2003. Comprehensive Sericulture. Vol. II. Silkworm Rearing and Silk Reeling. Oxford & IBH, New Delhi.
2. Partiban S & David BV. 2007. Management of Household Pests and Public Health Pests. Namratha Publ., Chennai.
3. Singh S. 1975. Beekeeping in India. ICAR, New Delhi.

4. Supporting Courses

4.1. Courses' Structure at a Glance

Course Code	Course Title	Credits
FST 455/11060203	Experimental Designs	3(2+1)
PP 509/11060220	Physiology of Crop Plants-I	2(2+0)
PP 506/11060316	Physiology of Crop Plants-II	2(2+0)

4.1.1. Course Content

FST 455/11060203: EXPERIMENTAL DESIGNS 3(2+1)

Objective

This course is meant for students of agricultural and other related sciences. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

UNIT-1

Need for designing of experiments, characteristics of a good design. Basic principles of designs - randomization, replication and local control.

UNIT-2

Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

UNIT-3

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

UNIT-4

Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, Lattice design, Response surfaces.

UNIT-5

Bioassays- direct and indirect, potency estimation.

Practical

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Fitting of response surfaces and Bioassays.

Suggested Readings

1. Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
2. Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
3. Federer WT. 1985. Experimental Designs. MacMillan.
4. Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
5. Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publication
6. Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
7. Design Resources Server: www.iasri.res.in / design.

PP 509/11060220: Physiology of Crop Plants-I 2(2+0)

Objective

To impart knowledge of physiological aspects of different crop plants.

Theory

UNIT-1

Origin, evolution and distribution of crop, adaptability of crop to different agro climatic conditions (specific case studies of important cereal crops like wheat, rice, barley, maize, sorghum and minor millets).

UNIT-2

Crop characteristics-growth and development (both vegetative and reproductive), physiological processes governing productivity

UNIT-3

Influence of climatological factors (water, temperature, photoperiod and light) on crop growth attributes and physiological processes.

UNIT-4

Special problems of each crop, crop ideotype concept and source sink relationship.

Suggested Readings

1. Gardner, F.P., Pearce, R.B. and Mitchell, R.L. 1988. Physiology of Crop Plants. Scientific Publ.
2. Pessarakli, M. 2002. Handbook of Plant and Crop Physiology. Marcel and Dekker Inc. New York.
3. Satorre, E.H. and Slafer, G.A. (Eds) 1999. Wheat: Ecology and Physiology of yield determiniation.Food Product Press, New York.

PP 506/11060316: Physiology of Crop Plants-II 2(2+0)

Objective

To impart knowledge of physiological aspects of different crop plants.

Theory

UNIT-1

Origin, evolution and distribution of crop, adaptability of crop to different agro climatic conditions. Specific case studies: Oilseeds: rapeseed mustard, groundnut and sunflower. Pulses: mungbean, pigeonpea, soybean cowpea and chickpea)

UNIT-2

Crop characteristics-growth and development (both vegetative and reproductive), physiological processes governing productivity

UNIT-3

Influence of climatological factors (water, temperature, photoperiod and light) on crop growth attributes and physiological processes.

UNIT-4

Special problems of each crop, crop ideotype concept and source sink relationship.

Suggested Readings

1. Gardner, F.P., Pearce, R.B. and Mitchell, R.L. 1988. Physiology of Crop Plants. Scientific Publishers, Jodhpur.
2. Pessarakli, M. 2002. Handbook of Plant and Crop Physiology. Marcel and Dekker Inc. New York

5. Compulsory Non-Credit Courses

5.3.Courses' Structure at a Glance

Course Code	Course Title	Credits
PGS 501/11060111	Library and Information Services	1(0+1)
PGS 502/11060204	Technical Writing and Communications Skills	1(0+1)
PGS 503/11060205	Intellectual Property and Its Management in Agriculture (e-Course)	1(1+0)
PGS 504/11060206	Basic Concepts in Laboratory Techniques	1(0+1)
PGS 505/11060306	Agricultural Research, Research Ethics and Rural Development Programmes(e-Course)	1(1+0)
PGS 506/11060106	Disaster Management (e-Course)	(1+0)

Note: Course content of compulsory non-credit courses in given in Agronomy Section.

6. Semester-wise Course Structure

6.1. Course Structure: 1st Semester

Course Code	Course Title	Theory +Practical	L	T	P	Credits
11060115	Introductory Mycology	Theory+ Practical	2	0	1	3(2+1)
11060116	Introductory Plant Bacteriology	Theory+ Practical	2	0	1	3(2+1)

11060117	Principles of Plant Disease Management	Theory+ Practical	2	0	1	3(2+1)
11060118	Principles of Plant Pathology	Theory	3	0	0	3(3+0)
11060119	Detection and Diagnosis of Plant Diseases	Practical	0	0	2	2(0+2)
11060106	Disaster Management (e- Course)	Theory	1	0	0	1(1+0)
11060111	Library and Information Services	Practical	0	0	1	1(0+1)
11060406	Master's Research	Practical				

6.2. Course Structure: 2nd Semester

Course Code	Course Title	Theory +Practical	L	T	P	Credits
11060214	Introductory Plant Virology	Theory+ Practical	2	0	1	3(2+1)
11060215	Epidemiology and Forecasting of Plant Diseases	Theory+ Practical	2	0	1	3(2+1)
11060216	Major Pests of Crops and Their Management	Theory+ Practical	1	0	2	3(1+2)
11060217	Biological Control of Crop Pests and Weeds	Theory+ Practical	1	0	1	2(1+1)
11060204	Technical Writing and Communications Skills	Practical	0	0	1	1(0+1)
11060219	Chemicals in Plant Disease Management	Theory+ Practical	2	0	1	3(2+1)
11060205	Intellectual Property & Its Management in Agriculture (e-Course)	Theory	1	0	0	1(1+0)
11060218	Principles of Integrated Pest Management	Theory+ Practical	1	0	1	2(1+1)
11060203	Experimental Designs	Theory+ Practical	2	0	1	3(2+1)
11060220	Physiology of Crop Plants-I	Theory	2	0	0	2(2+0)
11060406	Master's Research	Practical				

6.3 Course Structure: 3rd Semester

Course Code	Course Title	Theory +Practical	L	T	P	Credits
11060306	Agricultural Research, Research Ethics & Rural Development Programmes(e-Course)	Theory	1	0	0	1(1+0)
11060311	Biocontrol of Plant Diseases	Theory+ Practical	2	0	1	3(2+1)
11060312	Seed Pathology	Theory+ Practical	1	0	1	2(1+1)
11060313	Commercial Entomology	Theory+ Practical	1	0	1	2(1+1)

11060314	Mushroom Production	Theory+ Practical	2	0	1	3(2+1)
11060315	Nematode Diseases of Crops	Theory+ Practical	2	0	1	3(2+1)
11060316	Physiology of Crop Plants-II	Theory	2	0	0	2(2+0)
11060405	Master's Seminar	Theory	1	0	0	1(1+0)
11060406	Master's Research	Practical				

6.4. Course Structure: 4th Semester

Course Code	Course Title	Theory +Practical	L	T	P	Credits
11060406	Master's Research	Practical				

7. E- Resources for Information on Plant Pathology

1. American PhytopathologicalSociety. APS Home (apsnet.org)
2. Indian PhytopathologicalSociety Indian Phytopathological Society (ipsdis.org)
3. Indian mycological Society Welcome to Indian Mycological Society (imskolkata.org)
4. Central Institute of Medicinal & Aromatic Plants(CIMAP)http://www.cimap.org/
5. Central Plantation Crops Research Institute(CPCRI), Kasaragod, Keralahttp://cpcri.nic.in/
6. Central Tuber Crops Research Institute (CTCRI),Thiruvananthapuram, Keralahttp://www.ctcri.org/
7. Consultative Group on International AgriculturalResearch, CGIARhttp://www.cgiar.org/
8. Coffee Board, India http://indiacoffee.org/Department of Agriculture and Co-operation,Indiahttp://agricoop.nic.in/
9. Department of Bio-technology, India http://dbtindia.nic.inDepartment of Scientific and Industrial Research,Indiahttp://dsir.nic.in/
10. FAO http://www.fao.org/Global Agribusiness Information Network:http://www.fintrac.com/gain/:
11. Indian Agricultural Research Institute (IARI) http://www.iari.res.in/
12. Indian Council of Agricultural Research (ICAR) http://www.icar.org.in
13. Indian Journal of Entomology www.entosocindia.org
14. Indian Journal of Entomology Research www.entomologyjournal.com