

# SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC  
u/s (2f) of UGC Act 1956]



## SYLLABUS

### M.Sc. (Ag.) Horticulture

School of Agricultural Sciences  
(w.e.f. 2021-22)

## OUTCOME BASED EDUCATION

### Programme Outcome (PO) of M.Sc. Agriculture

#### Programme outcome (PO)

Students post graduating with M.Sc. Agriculture degree will be able to acquire:

<b>PO 1:</b>	Quality education in Agriculture with special reference to Agronomy, Soil Science, Horticulture, Entomology, Plant Pathology, Seed Science & Technology and crop improvement to the solution of Agriculture related issues.
<b>PO 2:</b>	Understand and analyze the current events and issues that are occurring in agriculture and how they affect futuristic agriculture.
<b>PO 3:</b>	Skills to select and apply natural resources, modern techniques and IT tools for weather forecasting, soil analysis, pest management and quality seed production of food crops.
<b>PO 4:</b>	Research oriented innovative ideas should be recognized and examine the relationship between inputs and outputs in their agricultural field to make profitable decisions.
<b>PO 5:</b>	Research based knowledge of the environment and recognizes the importance of crop biodiversity in the field to preserve agro-ecosystem
<b>PO 6:</b>	Able to recognize and examine the relationship between employer and students which enhance career opportunities in different sectors
<b>PO 7:</b>	Demonstrate the impact of globalization and diversification of agriculture. extension programmes to disseminate modern technologies for farmer's welfare
<b>PO 8:</b>	To engage in critical thinking by analyzing situations and constructing viable solutions with ability to work effectively with each.
<b>PO 9:</b>	The Skills to recognize and evaluate the relationships between input and outputs, cost: benefit ratio in their agricultural field to make effective decision .The programme will enhance job opportunities and entrepreneurship development
<b>PO 10:</b>	Self critical opinion to solve the on farm problems on sustainable basis. The students will generate a culture of lifelong learning in an inclined environment to get personal achievement and professional ethics
<b>PO 11:</b>	Know the recent development, future possibilities in agriculture sector. Provide comprehensive knowledge of agriculture production.
<b>PO 12:</b>	The students will generate a culture of lifelong learning in an inclined environment to get personal achievement and professional ethics.

## M.Sc. (Ag.) Horticulture

### Programme Specific Outcome (PSO)

<b>PSO 1:</b>	Students having a combined knowledge of Horticulture Science with entrepreneurial skills enable them to get administrative or marketing positions with organizations involved in the production and marketing of fruits, vegetables and flowers.
<b>PSO2:</b>	They also get recruited in the companies as horticulturists, gardeners, supervisors, farm or estate managers, landscape designer, handling large scale production of certain varieties of horticultural crops in various private sector companies etc.
<b>PSO3:</b>	At the National and International levels, different agencies appoint horticultural consultants and other different positions as per their requirement.
<b>PSO4:</b>	Lengthen the post harvest storage life of horticultural commodities and increase income through value addition of the products and to reduce post harvest losses.

# **School of Agricultural Sciences**

## **'ACADEMIC RULES AND REGULATIONS'** **(Effective from 2021-22)**

### **01. Regulations**

The Regulations provided herein shall apply to M.Sc. Agriculture Degree Programme offered by the Shri Guru Ram Rai University.

### **02. Short Title and Commencement**

These regulations shall be called "M.Sc. Agriculture Degree Programme Academic Rules and Regulations 2021". They shall come into force from the academic year 2021-22.

### **03. Definitions & Abbreviations**

**3.1 'University'** means the Shri Guru Ram Rai University, Pathribagh, Dehradun, Uttarakhand.

**3.2 'Curriculum'** is a group of courses and other specified requirements for the fulfillment of the Degree Programme.

**3.3 'Curricula and syllabi'** It includes a list of approved courses for the Degree Programme wherein each course is identified by course code, outline of syllabus, credit assigned and semester wise distribution.

**3.4 'Semester'** means a period consisting of 90 working days inclusive of the mid-semester and practical examinations but excluding the study holidays and final theory examinations in each semester. The broad schedule of two semesters is:

- a. Odd semesters (I & III): July to December
- b. Even semesters (II & IV): January to June

**3.5 'Academic Year'** means a period consisting of two consecutive semesters including the inter-semester break as announced by the University. The first year of study shall be the first and second semesters following student's admission. The second year of study shall be the third and fourth semesters.

**3.6 'Course'** is a teaching unit of a discipline to be covered within a semester as detailed in the Curricula and Syllabi issued by the University.

**3.7 Core Course:** Core course means the list of courses specified by the University in the curricula and syllabi to be registered compulsorily by the students of M.Sc. Agriculture Degree Programme.

**3.8 Elective Course:** Elective course means the list of courses specified by the University in the curricula and syllabi to be registered optionally by the students of M.Sc. Agriculture Degree Programme.

**3.9 Course Code:** Each course shall bear a distinguishing code (as mentioned in the evaluation scheme) that identifies the discipline from which it is being offered.

**3.10 “A credit”** in theory means one hour of class room lecture and a credit in practical means two and half hour of laboratory or field work per week.

*Explanation :*

A 1+1 course (2 credits) means 1 hour theory and two and half hour practical per week.

A 0+1 course (1 credit) means two and half hour practical per week.

A 1+0 course (1 credit) means 1 hour theory per week.

**3.11 ‘C’** is abbreviated for Core course

‘E’ for Elective course

‘L’ for Lecture

‘T’ for Tutorial

‘P’ for Practical or Lab work or Field work

#### **04. Eligibility for admission to M.Sc. Agriculture Degree Programme:**

Any candidate who has passed the B. Sc. Agriculture/ B.Sc. (Hons.) Agriculture /B.Sc. Horticulture/ B.Sc.(Hons.) Horticulture degree programme from a recognized college/Institute/University with not less than 45 %-marks in aggregate is eligible for admission.

**05. Admission Procedure:** As per the University Norms.

#### **06. System of Education**

**6.1** The system of education for M.Sc. Agriculture Degree programme is Semester System with duration of two academic years (4 Semesters). The maximum duration permissible for a student shall be 06 consecutive semesters (3 years). If a student at any stage of his/her course is found unable to complete it within the said time, he/she shall not be allowed to continue the studies further.

**6.2** The date of commencement and closure of semesters as well as inter-semester break and schedule of final theory examinations shall be announced by the University.

**6.3** Credits are assigned to each course in M.Sc. Agriculture on the basis of the number of theory classes or lectures and Practical classes or laboratory work or field work as well as other form of learning required to complete course content in a scheduled period as decided by the University.

**6.4** Core courses prescribed are mandatory for all the students registered in M.Sc. Agriculture Degree programme.

**6.5** There shall be one compulsory elective course in Semester-III.

**6.6** Master's Thesis shall be offered in fourth semester.

**6.7** An academic calendar shall be prepared by the University for every semester indicating the date of commencement and closure of semesters, date of mid semester examinations, final practical and theory examinations, inter semester break and holidays.

**6.8 Summary of Credits in M.Sc. (Ag.) Horticulture (All Semesters)**

Semester	Core course	Elective course	Total credits
I	16	-	16
II	14	-	14
III	10	3	13
IV	23	-	23
<b>Grand Total</b>			<b>66</b>

**6.9** A student must successfully complete a total of 66 credits which include 63 credits for core courses + 03 for Elective courses as per the Curriculum requirement of M.Sc. Agriculture Degree programme

**6.10** A course shall be offered only once in an academic year during the semester as listed in the course curricula and syllabi.

**07. The Medium of Instruction:** The medium of instruction will be in English.

**08. Reservation:** The reservation will be as per the State Government rules / University Norms and Policies.

**09. Total Seats:** The total seats in M.Sc. Agriculture degree programme will be as per the provision of the University.

**10. Fee structure:** As decided by the University.

**11. Attendance:** As per University Norms.

**12. Examination and Evaluation:** As per University Norms with following guidelines

**12.1 The medium of Examination:** The medium of Examination will be English.

**12.2 Duration of examinations:** The examinations shall be conducted according to the description given below:

Examination	Courses with theory and practical	Courses with only theory	Courses with only practical
Mid-semester Examination (Internal)	1.0 hour	1.0 hour	--
Final Theory Examination	2.5 hours	2.5 hours	--
Final Practical Examination	3.0 hours	--	3.0 hours

### 12.3 Distribution of marks in External and Internal Exams:

**(a) Courses with Theory and Practical both (Maximum Marks 100):**

- External Theory Examination (50% or 50 marks) in each paper
- Internal Mid-term Examinations (30% or 30 marks) in each paper
- Internal Practical Examination (20% or 20 marks) in each paper

**(b) Courses with only Theory (Maximum Marks 100):**

- External Theory Examination (50% or 50 marks) in each paper
- Internal Mid-term Exams (40% or 40 marks) + Assignment (10% or 10 marks) in each paper

**(c) Courses with only Practical (Maximum Marks 100):**

- Internal Practical Examination (100% or 100 marks) in each paper

### 12.4 Assessment Norms: As per University Norms

### 12.5 Question paper pattern:

Paper to be set by external: HOD shall ensure the coverage of syllabus. If needed moderation question paper can be done.

Evaluation is to be done internally by the faculty other than the Course Instructor. Syllabus of the concerned course shall be sent to the external examiner, who shall prepare the question papers. For practical, it is recommended that examination shall be conducted by course instructor(s) and one teacher nominated by HOD.

**(a) External theory Examinations for courses with theory and practical:**

The question paper pattern for External theory Examination (Maximum Marks: 50) for courses with theory and practical is given below:

SECTION	Type of question	Number of questions	Number of questions to be answered	Mark per question	Total Marks
A	Objectives	10	10	01	10
B	Short answer type	06	04	05	20
C	Long answers type	03	02	10	20

<b>Total</b>	<b>50</b>
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**(b) External theory Examinations for courses with theory only:**

The question paper pattern for External theory Examinations (Maximum marks: 50) for courses with only theory shall be as per given in section 12.5 (a).

**(c) Mid-term Exam:**

Courses with theory and practical both shall contain two Mid-term Exams of 15 marks each. Courses with only theory shall contain two mid-term Exams of 20 marks each plus an assignment of 10 marks. Question paper for Mid-term Exams can be designed by Examiner as per the requirement of course content including objective and short answer type questions.

**(d) Practical Exam:**

Courses with theory and practical shall contain one practical Exam of 20 marks.

**(e) Practical Examinations for courses with practical only:**

Courses with practical only shall contain one practical Exam of 100 marks including Field work/Viva (50 marks) + Lab record (15 marks) + Assignment (15 marks) + Presentation (20 marks).

**(f) Master's Thesis evaluation:** Evaluation of "Master's Thesis (MSHT-402)" will be as Satisfactory/Unsatisfactory and will not be used for calculation of GPA/CGPA/OGPA.

**13. Submission of Master's Thesis:** As per University Norms.

**14. Promotion of students to next semester:** Cases of students' promotion to next semester such as Back papers, Carry over system, Ex – Studentship, Special examination, Grace marks, Candidate leaving the semester will be as per the University Norms and policies.

**15. Approval of Final Results, Award of Degree and Issue of Provisional Certificates and Transcripts or Mark sheet:** As per University Norms

**16. Removal of Difficulties:**

**16.1** If any difficulty arises in giving effect to the Provisions of these regulations, the University may issue necessary orders which appear to be necessary or expedient for removing the difficulty.

**16.2** Every order issued by the University under this provision shall be laid before the Academic Council of the University immediately after the issuance.

**16.3** Notwithstanding anything contained in the rules and regulations, the Board of Studies or Academic Council shall make changes whenever necessary.



**DEPARTMENT OF HORTICULTURE**

S.G.R.R. University, Pathri Bagh, Dehradun, Uttarakhand, India-248 001

**Course Curriculum for M. Sc. (Ag.) Horticulture, 2021-22**  
**Course offered****Core Courses**

<b>Course No.</b>	<b>Course Title</b>	<b>Credits</b>
MSHC-101	Statistical Methods and Experimental Designs	4(3-0-1)
MSHC-102	Advances in Orchard Management	3(2-0-1)
MSHC-103	Advances in Olericulture	3(2-0-1)
MSHC-104	Plant Propagation and Nursery Management	3(2-0-1)
MSHC-105	Systematic Horticulture	3(2-0-1)
MSHC-201	Advances in Floriculture and Landscaping	3(2-0-1)
MSHC-202	Advances in Breeding of Vegetable Crops	3(2-0-1)
MSHC-203	Biotechnology of Horticultural Crops	3(2-0-1)
MSHC-204	GAP for Horticultural Crops	2(2-0-0)
MSHC-205	Advances in Post- Harvest Technology and Management of Fruits and Vegetables	3(2-0-1)
MSHC-301	Protected Cultivation of Horticultural Crops	3(2-0-1)
MSHC-302	Advances in Growth and Development of Horticultural Crops	3(2-0-1)
MSHC-303	Advances in Pomology	3(2-0-1)
MSHS-304	Master'Seminar	1(0-0-1)
MSHC-401	Organic Horticulture	3(2-0-1)
MSHT-402	Master's Thesis	20(0-0-20)
	<b>Total</b>	<b>63(29-0-34)</b>

**Elective Courses**

<b>Course No.</b>	<b>Course Title</b>	<b>Credits</b>
MSHE-305	Advances in Breeding of Ornamental Crops	3(2-0-1)
MSHE-306	Biodiversity and conservation of fruit crops	3(2-0-1)
MSHE-307	Biotic and Abiotic Stress Management in Horticultural Crops	3(2-0-1)
MSHE-308	Canopy Management in Fruits Crops	3(2-0-1)
	<b>Total</b>	<b>12(8+0+4)</b>

**SEMESTER WISE DISTRIBUTION OF COURSES****M.Sc. (Ag.) Horticulture**  
**Elective Course System (ECS)****Semester-I**

S.No.	Course Code	Course Title	Credit distribution				MM
			L	T	P	Total	
1.	MSHC-101	Statistical Methods and Experimental Designs	3	0	1	4	100
2.	MSHC-102	Advances in Orchard Management	2	0	1	3	100
3.	MSHC-103	Advances in Olericulture	2	0	1	3	100
4.	MSHC-104	Plant Propagation and Nursery Management	2	0	1	3	100
5.	MSHC-105	Systematic Horticulture	2	0	1	3	100
		<b>Total</b>		<b>16(11+0+5)</b>			<b>500</b>

**Semester-II**

S.No.	Course Code	Course Title	Credit distribution				MM
			L	T	P	Total	
1.	MSHC-201	Advances in Floriculture and Landscaping	2	0	1	3	100
2.	MSHC-202	Advances in Breeding of Vegetable Crops	2	0	1	3	100
3.	MSHC-203	Biotechnology of Horticultural Crops	2	0	1	3	100
4.	MSHC-204	GAP for Horticultural Crops	2	0	0	2	100
5.	MSHC-205	Advances in Post- Harvest Technology and Management of Fruits and Vegetables	2	0	1	3	100
		<b>Total</b>		<b>14(10+0+4)</b>			<b>500</b>

**Semester-III**

S.No.	Course Code	Course Title	Credit distribution				MM
			L	T	P	Total	
1.	MSHC-301	Protected Cultivation of Horticultural Crops	2	0	1	3	100
2.	MSHC-302	Advances in Growth and Development of Horticultural Crops	2	0	1	3	100
3.	MSHC-303	Advances in Pomology	2	0	1	3	100
4.	MSHS-304	Master's Seminar	0	0	1	1	100
<b>Elective course (Students have to select any one)</b>							
5.	MSHE-305	Advances in Breeding of Ornamental Crops	2	0	1	3	100
6.	MSHE-306	Biodiversity and conservation of fruit crops	2	0	1	3	100
7.	MSHE-307	Biotic and Abiotic Stress Management in Horticultural Crops	2	0	1	3	100
8.	MSHE-308	Canopy Management in Fruits Crops	2	0	1	3	100
		<b>Total</b>	<b>13(8+0+5)</b>				<b>500</b>

**Semester-IV**

S.No.	Course Code	Course Title	Credit distribution				MM
			L	T	P	Total	
1.	MSHC-401	Organic Horticulture	2	0	1	3	100
2.	MSHT-402	Master's Thesis	0	0	20	20	Satisfactory
		<b>Total</b>		<b>23(2+0+21)</b>			<b>100</b>

**Summary of Credits in M.Sc. (Ag.) Horticulture (All Semesters)**

<b>Semester</b>	<b>Core course</b>	<b>Elective course</b>	<b>Total credits</b>
I	16	-	<b>16</b>
II	14	-	<b>14</b>
III	10	3	<b>13</b>
IV	23	-	<b>23</b>
<b>Grand Total</b>			<b>66</b>

# SYLLABUS

## M.Sc. (Ag.) HORTICULTURE

### Semester – I

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-101	Credit	4(3+1)
Year/Sem	1/I	L-T-P	3-0-1
Course Name	<b>Statistical Methods and Experimental Designs</b>		

**Course Objectives:**

1. To educate basics terms used in collection, classification, presentation and analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
2. To develop understanding of use of various formulas, principles and methods of statistical calculations used in agriculture.
3. To develop skills in methods of collection of any type of data, classification of data, presentation of data, analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
4. To analyze results of statistical calculations and their validation.

**UNIT I (Total Topics - 5 and Hrs -5)**

Processing of data: Classification and tabulation of statistical data by categories and measurements, graphical and diagrammatic representation-histogram. Frequency polygon, frequency curve and cumulative frequency curves.

**UNIT II (Total Topics - 6 and Hrs -6)**

Measure of location and dispersion: Mean, median, mode, partition values (quartiles, deciles and percentiles). Range, quartile deviation, mean deviation about mean and median, standard deviation coefficient of variation, moment kurtosis.

**UNIT- III (Total Topics – 7 and Hrs -7)**

Probability & distribution: Random experiment, sample space (discrete case only), events mathematical and statistical definition of probability, random variable (discrete and continuous), bermoulli trials, binomial distn. posson distn. Poision distn as a limiting case of the bionominal distn, normal sistn, properties of the above distributions and fitting with available date, Test for their goodness of fit.

**UNIT-IV (Total Topics - 5 and Hrs -5)**

Correlation and regression : Bivariate dats, bivariate frequency distn, correlation coefficient, rank correlation, Regression lines, regression coefficients and their relation with correlation coefficient, Multiple regression, multiple and partial correlation coefficients.

**UNIT-V (Total Topics - 6 and Hrs -6)**

Estimation: Concept of population and sample; parameters and statistics: criteria for a good estimator unbiasedness, consistency of population mean and its confidence internal in the normal case. Testing of hypothesis: Null and alternative hypotheses, two type of errors, level of significance, power of the test, one tailed and two tailed tests.

**UNIT-VI (Total Topics - 7 and Hrs -7)**

Tests of significance: (a) large sample tests for mean & equality of means of two populations (2 tests). Student's statistic and its use of testing the mean equality of means of two populations (with independent and paired observations) correlation coefficient and regression coefficients. (b) Chi-Square statistics and its use as a test of goodness of fit, independence of attributes (contingency table) with Yates correction, and testing for the variance of a population. (c) Fishers statistic and its use in testing the equality of two variances and homogeneity of means (analysis of variance).

**UNIT-VII (Total Topics - 4 and Hrs -4)**

Analysis of variance and covariance (ANOVA and ANCOVA): Analysis of variance and covariance with one way and two-way classifications (one observation per cell). Bartlett's test for testing the homogeneity of variances.

**UNIT-VIII (Total Topics - 5 and Hrs -5)**

Design of experiments: Need: uniformity trials, Principles of experimental design replication, randomization and local control, (a) Completely Randomized Design, Randomized Block Design and Latin Square Designs and their analysis, missing plot technique in RBD. (b) Simple factorial experiments of the type 2<sup>2</sup>, 3<sup>2</sup>, 2<sup>3</sup>, 3<sup>2</sup>, confounding in factorial experiments. (c) Split-plot experiments.

**Practical (Experiments- 7 and Hrs -14)**

- Presentation of data-tabulation, histograms and frequency polygons
- Calculation of mean, mode, standard deviation, skewness and kurtosis
- Calculation of expected frequencies in binomial, Poisson and normal distributions testing the observed results against expected frequencies
- Tests of significance as prescribed in theory
- Regression and correlation coefficients and their significance
- Analysis of variance for different designs prescribed
- Analysis of covariance

**Course Outcomes (COs):**

CO1: Define the basic concept of statistics, t-test, f-test, hypothesis, sampling etc.

CO2: Understand the role of statistics in research experiments.

CO3: Choose and prepare experimental designs.

CO4: Analyze the results of statistical calculations and their validation.

CO5: Understand theoretical as well as practical knowledge of different formulas.

CO6: Analysis of data pertaining to attributes and to interpret the results.

**Suggested readings:**

- Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
- Nageswara Rao, G. 2007. Statistics for Agricultural Sciences. B.S. Publications, Hyderabad.
- Panse, V. G. and Sukhatme, P. V. 1961. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research.
- Rangaswamy, R. 1995. A Text Book of Agricultural Statistics. New Age International Publishing Limited, Hyderabad.
- S.R.S. Chandel. 2007. A Handbook of Agricultural Statistics. Anchal Prakashan Madir, Kanpur-208005.
- Snedecor, G. W. and Cochran, W.G. 1989. Statistical Methods 8th Edition. Iowa State University Press.

**Articulated Attainment**

COs/ POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	1	1	1	-	1	1	2	1	-	-	-	-	1	-	1
CO-2	1	1	1	2	1	2	-	1	1	1	2	1	-	2	-	3
CO-3	2	2	2	1	-	1	-	2	2	3	1	2	2	1	-	1
CO-4	1	1	1	1	-	1	1	1	1	-	-	-	-	1	-	-
CO-5	1	1	2	2	1	2	1	1	1	2	2	1	1	2	1	3
CO-6	1	2	2	2	1	1	3	1	1	1	2	1	-	2	-	3
Average	1.3	1.3	1.5	1.5	1.0	1.3	1.5	1.3	1.2	1.75	1.75	1.25	1.5	1.5	1.0	2.2

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-102	Credit	3(2+1)
Year/Sem	1/I	L-T-P	2-0-1
Course Name	<b>Advances in Orchard Management</b>		

**Course Objectives:**

1. To equip themselves with know-how on agro-techniques for establishment and management of an orchard leading to optimum and quality fruit production.
2. To develop understanding of different systems of layout, planting, floor management practices.
3. To study about of drip and sprinkler irrigation.
4. To impart knowledge of excess & deficiency of minerals, INM and IPM practices in orchard.

**UNIT I (Total Topics - 3 and Hrs -3)**

Importance and scope of orchard management, constraint in fruit production, concept of high density planting.

**UNIT II (Total Topics - 3 and Hrs -3)**

Orchard soil management systems, water requirement of fruit trees, factors affecting water requirement.

**UNIT- III (Total Topics - 6 and Hrs -6)**

Classification of soil moisture, effect of soil moisture on fruit trees, disorders due to excess and deficient moisture, various factors affecting moisture supply to plants, drip and sprinkler irrigation, fertigation.

**UNIT-IV (Total Topics - 7 and Hrs -7)**

Multistory cropping, drainage systems, organic manures, fertilizers and bio fertilizers, role of elements in fruit production, disorders due to excess and deficiency of elements, evaluating need for nutrients/tissue analysis; integrated nutrient management(INM).

**UNIT-V (Total Topics - 6 and Hrs -6)**

Recent techniques of training and pruning, fruit thinning, splitting of fruits, preharvest fruit drop, rejuvenation of old orchards.

**UNIT-VI (Total Topics - 5 and Hrs -5)**

Internal and external factors of unfruitfulness, practices to induce flowering; irregular bearing of fruit trees. Hardiness, winter killing, injuries and their protection, IPM, protection from important insects and diseases.

**Practical (Experiments- 5 and Hrs -10)**

- Study of different systems of layout, planting, study of drip and sprinkler irrigation.
- Identification and control of important diseases and insects, soil and foliar application of fertilizers.
- Study of deficiency symptoms of elements, practice of pruning and training, rejuvenation of old orchards, tissue analysis, physical practices to induce flowering.
- Use of bioregulators, cost of cultivation of an orchard.
- Visit to important orchards and Fruit Research Stations.

**Course Outcomes (COs):**

CO1: Memories agro-techniques for establishment and management of an orchard

CO2: Summarize excess & deficiency of minerals, INM and IPM practices in orchard

CO3: Layout, planting, floor management practices and study of drip and sprinkler irrigation.

CO4: Analyze the factors for unfruitfulness, practices for promoting fruit production and its management.

CO5: Appreciate the research advancements made in orchard management.

CO6: Understand to recommend suitable package of practices for enhanced production of fruit crops.

**Suggested readings:**

- Dhillon, W.S. and Bhatt. 2011. Fruit Tree Physiology. Narendra Publishing House, New Delhi.
- Kumar, N. 1997. Introduction to Horticulture Crops. Rajyalakshmi Publications, Nagercoil, Tamilnadu.
- Kumar, T.P. Suma, B. Bhaskar, J. and Satheson, K. N. 2008. Management of Horticultural Crops. New India Publishing Agency, New Delhi.
- Mazumdar, B.C. 2004. Orchard Irrigation and Soil Management Practices. Daya Publishing Agency, New Delhi.
- Mazumdar, B.C. 2004. Principles and Methods of Orchard Establishment. Daya Publishing House, New Delhi.
- Palaniappan, S. P. and Sivaraman, K. 1996. Cropping Systems in the Tropics. New Age International (P) Ltd., New Delhi.
- Shanmugavelu, K.G. 1989. Production Technology of Fruit Crops. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PS -4
CO-1	2	3	1	1	-	1	1	2	1	3	-	-	2	2	2	1
CO-2	1	3	1	2	1	2	-	1	1	3	2	1	2	2	2	1
CO-3	2	1	2	1	-	1	-	2	2	-	1	2	1	1	3	-
CO-4	1	3	1	1	-	1	1	1	1	-	-	-	1	1	2	1
CO-5	1	1	2	1	1	1	1	-	2	1	1	2	1	1	2	1
CO-6	1	2	1	1	2	1	1	1	1	2	1	1	1	2	1	1
Average	1.3	2.1	1.3	1.16	1.3	1.16	1.0	1.4	1.3	2.25	1.25	1.5	1.3	1.5	2.0	1.0

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-103	Credit	3(2+1)
Year/Sem	1/I	L-T-P	2-0-1
Course Name	<b>Advances in Olericulture</b>		

**Course Objectives:**

1. To educate about advanced production technology of Solanaceous, root, cole, legume, bulb and cucurbitaceous vegetables.
2. To impart knowledge about origin, distribution, area, production, classification and description of cultivars of vegetables.
3. To study about sowing times, seed rate, nutritional and irrigation requirement, weed control, mulching, use of bioregulators in vegetables.
4. To develop understanding about the physiological disorders, harvesting, yield, post-harvest management, plant protection measures and seed production of vegetables.

**UNIT I (Total Topics - 3 and Hrs -3)**

Importance of vegetables, area and production in state, India and World, types of vegetable gardening, classification of vegetables.

**UNIT II (Total Topics - 6 and Hrs -6)**

Origin and distribution, area and production, taxonomy, classification and description of cultivars, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operation, weed control, mulching, use of bioregulators, physiological disorders, harvesting, yield, post-harvest management, plant protection measures and seed production of the following vegetables:

**UNIT- III (Total Topics - 4 and Hrs -4)**

Solanaceous Vegetables- Potato, Tomato, Brinjal, Chilli, Capsicum

**UNIT-IV (Total Topics - 5 and Hrs -5)**

Root Vegetables- Radish, Turnip, Carrot, Beet root  
Cole Vegetables- Cauliflower, Cabbage, Knol-khol

**UNIT-V (Total Topics - 5 and Hrs -5)**

Legume Vegetables- Peas and French bean  
Bulb Vegetables- Onion, Garlic, Leek

**UNIT-VI (Total Topics - 7 and Hrs -7)**

Cucurbits- Cucumber, Water melon, Bottle gourd, Sponge gourd, Musk melon, Pumpkin etc.  
Leafy Vegetables- Spinach, Amaranthus  
Others- Okra and Sweet Potato

**Practical (Experiments- 5 and Hrs -10)**

- Identification and morphological features of vegetables
- Study of physiological disorders, use of bioregulators, basal and foliar application of nutrients
- Seed extraction techniques
- Identification of important pests and diseases and their control
- Cost of vegetable cultivation, experimental trials
- Visit to vegetable research centers and processing units.

**Course Outcomes (COs):**

CO1: Identify root, Cole, legume, bulb and cucurbitaceous vegetables.

CO2: Summarize origin, distribution, area, production, classification and description of cultivars of vegetables.

CO3: Relate sowing times, seed rate, nutritional and irrigation requirement in vegetables.

CO4: Correlate physiological disorders, plant protection measures and seed production of vegetables.

CO5: Develop skills for growing vegetable crops.

CO6: Apply knowledge of intercultural practices for improving yield of vegetable crops.

**Suggested readings:**

- Bose, T.K. and Som, M.G. 1986. Vegetables Crops in India. Naya Prokash.
- Bose, T.K., Kabir, J., Maity, T.K., Parthasarathy, V.A. and Som, M.G. 2003. Vegetables Crops (Vols. I to III). Naya Udyog.
- Bose, T.K., Som, M.G. and Kabir, J. 2002. Vegetables Crops in India. Naya Prokash.
- Chadha, K.L. 2002. Hand Book of Horticulture. ICAR, New Delhi.
- Chadha, K.L. and Kalloo, G. 1994. Advances in Horticulture (Vol. V to X). Malhotra Publ. House.
- Chauhan, D.V.S. 1986. Vegetable Production in India. Ram Prasad and Sons.
- Decoteau, D.R. 2000. Vegetable Crops. Prentice Hall.
- Edmond, J.B., Musser, A.M. and Andrews, F.S. 1951. Fundamentals of Horticulture. Blakiston Co.
- Fageria, M.S., Choudhary, B.R. and Dhaka, R.S. 2000. Vegetable Crops: Production Technology (Vol. II). Kalyani Publishers.
- Gopalakrishanan, T.R. 2007. Vegetable Crops. New India Publ. Agency.
- Hazra, P. and Som, M.G. 1999. Technology for Vegetable Production and Improvement. Naya Prokash.
- Rabatzky, V.E. and Yamaguchi, M. 1997. World Vegetable: Principal, Production and Nutritive Values. Chapman and Hall.
- Rana, M.K. 2008. Olericulture in India. Kalyani Publication.
- Rana, M.K. 2008. Scientific Cultivation of Vegetables. Kalyani Publication
- Saini, G.S. 2001. A Text Book of Olericulture and Floriculture. Aman Publication House.
- Salunkhe, D.K. and Kadam, S.S. 1998. Hand Book of Vegetables Science and Technology Production, Composition, Storage and processing. Marcel Dekker.
- Shanmugavelu, K.G. 1989. Production Technology of Vegetable Crops. Oxford and IBH.
- Singh, D.K. 2007. Modern Vegetable Varieties and Production Technology. International Book Distributing Co.
- Singh, S.P. 1989. Production Technology of Vegetable Crops. Agri. Comm. Res. Centre.
- Thamburaj, S. and Singh, N. 2004. Vegetables, Tuber Crops and Spices. ICAR.
- Thompson, H.C. and Kelly, W.C. 1978. Vegetables Crops. Tata McGraw-Hill.

**Articulated Attainment**

COs/ POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	3	2	1	1	1	-	-	1	-	1	-	2	-	-	-
CO-2	1	3	2	2	1	1	-	-	1	1	1	1	2	-	-	-
CO-3	2	2	1	1	2	3	1	-	2	3	2	3	1	-	-	-
CO-4	1	2	1	1	1	1	3	1	1	-	1	-	1	1	-	1
CO-5	1	1	2	1	2	2	1	3	2	3	2	1	1	2	1	-
CO-6	1	1	1	2	1	1	2	1	1	2	1	-	1	1	1	1
Average	1.3	2.0	1.5	1.3	1.3	1.5	1.6	1.7	1.3	2.2	1.3	1.6	1.3	1.3	1.0	1.0

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-104	Credit	3(2+1)
Year/Sem	1/I	L-T-P	2-0-1
Course Name	<b>Plant Propagation and Nursery Management</b>		

**Course Objectives:**

1. To familiarize with principles and practices of propagation and nursery management for horticultural crops.
2. To study about propagation, sexual & asexual propagation methods, apomixis, polyembryony, chimeras.
3. To educate about principle factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.
4. To impart knowledge of micropropagation tools, nursery types, structure and management.

**UNIT I (Total Topics - 6 and Hrs -6)**

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 (Total Topics - 8 and Hrs -8)**

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 (Total Topics - 7 and Hrs -7)**

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 (Total Topics - 6 and Hrs -6)**

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 (Total Topics - 3 and Hrs -3)**

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

**Practical (Experiments- 6 and Hrs -12)**

- Practice of grafting, budding, cutting and layering
- Anatomical studies in rooting of cutting and graft union
- Planning and layout for commercial nursery, sample seed testing, use of bio-regulators in propagation, sterilization of equipments and laboratory,
- Media preparation, selection and preparation of explants, meristem culture and micro grafting.
- Planning and layout of experiments on various aspects of propagation.
- Visit to TC labs and nurseries

**Course Outcomes (COs):**

CO1: Memorize principles and practices of propagation and nursery management.

CO2: Classify and summaries propagation methods.

CO3: Analyze factors influencing seed germination, dormancy, hormonal regulation of germination and seedling growth of horticultural crops.

CO4: Categorize micro propagation tools, nursery types, structure and management.

CO5: Knowledge on physiology, principles, factors influencing, media and methods of propagation of Horticultural crops

CO6: -Gain skill in all propagation methods and technology for commercial scale adoption.

**Suggested readings:**

- Acquaah, G., Principles and practices of Horticulture.
- Bose, T.K., Mitra, S.K. and Sadhu, M.K., 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash.
- Hartmann, H.T. and Kester, D.E., 1989. Plant Propagation: Principles and Practices. Prentice Hall of India.
- Peter, K.V. 2008. Basic of Horticulture. New India Publ. Agency.
- Radha, T. and Mathew, L. 2007. Fruit Crops. New India Publ. Agency.
- Rajan, S. and Baby, L.M. 2007. Propagation of Horticultural Crops. New India Publ. Agency.
- Shanker, G. 1966. Practical Manual in Horticulture. Kitabistan Publication, Allahabad.
- Singh, S.P. 1989. Mist Propagation. Metropolitan Book Co.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	1	1	1	-	1	1	2	1	-	1	1	-	1	-	1
CO-2	1	1	1	2	1	2	-	1	1	1	1	2	-	2	-	3
CO-3	2	2	2	1	-	1	-	2	2	3	2	1	2	1	-	1
CO-4	1	1	1	1	-	1	1	1	1	-	1	1	-	1	-	-
CO-5	1	1	1	2	1	2	-	1	1	1	1	2	-	2	1	2
CO-6	2	1	2	1	2	1	1	2	1	3	2	1	2	1	1	1
Average	1.5	1.2	1.3	1.3	1.3	1.3	1.0	1.5	1.16	2.0	1.3	1.3	2.0	1.3	1.0	1.6

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-105	Credit	3(2+1)
Year/Sem	1/I	L-T-P	2-0-1
Course Name	<b>Systematic Horticulture</b>		

**Course Objectives:**

1. To study about introduction, scope and importance of systematic horticulture.
2. To develop the ability to differentiate among artificial, natural and modern systems and Nomenclature: importance, binomial classification and its salient features.
3. To educate about the various botanical description of families, genera and species of important horticultural plants.
4. To develop the skills in categories different fruit species and cultivars on basis of distinguishing features.

**UNIT I (Total Topics - 3 and Hrs -3)**

Introduction, importance and scope, botanical terminology. Plant classification, history and systems-artificial, natural and modern systems.

**UNIT II (Total Topics - 5 and Hrs -5)**

Nomenclature: importance, binomial classification and its salient features. Morphological description of (vegetative, floral and fruit features) of the following important families of fruits, vegetables and ornamental crops.

**UNIT- III (Total Topics - 8 and Hrs -8)**

Anacardiaceae - Mango, Cashewnut; Rutaceae- Citrus, . Murrayas, Kamini; Musaceae- Banana; Myrtaceae- Guava, Bottle brush, Rosaceae- Apple, Pear, Plum, Peach, Apricot, Loquat, Rose; Apocyanaceae- Karonda, Kaner, Chandini; Vitaceae- Grapes; Sepindaceae- Litchi; Caricaceae- Papaya.

**UNIT-IV (Total Topics - 6 and Hrs -6)**

Brassicaceae- cauliflower, cabbage, Radish, Turnip; Cucurbitaceae- Cucurbits; Solanaceae- Brinjal, Tomato, Chillies, Potato, Rat-ki-rani; Leguminaceae- Peas, Beans, Kachnar, Ashok, Cassia; Malvaceae- Bhindi, Hibiscus.

**UNIT-V (Total Topics - 8 and Hrs -8)**

Euphorbiaceae- Achalipha, Poinsettia, Croton; Nyctaginaeaceae-Bougainvillea; Rubiaceae- Hamelia, Mussanda, Ixoraparviflora; Ramnaceae- Ber; Amaryllidaceae- Onion, Garlic.

**Practical (Experiments- 6 and Hrs -12)**

- Identification and botanical description (vegetative and floral features) of available fruits, vegetables and ornamental plants.
- Visit to the horticulture research stations for identification of different species.

**Course Outcomes (COs):**

CO1: Memorize about introduction, scope and importance of systematic horticulture.

CO2: Classification and description of horticultural crops.

CO3: Familiarization with botanical description of families, genera and species of important horticultural plants.

CO4: Categories fruit species and cultivars on the basis of distinguishing features.

CO5: Understand cytological levels of various vegetable crops.

CO6: Aware with morphological features of horticultural crops.

**Suggested readings:**

- Bhattacharyya, B. 2009. Systematic Botany. Alpha Science International Ltd.

- Pandey, B.P. 2010. Botany for Degree Students. S. Chand & Company Ltd, New Delhi- 110055.
- Pandey, B.P. 2010. Modern Practical Botany. Chand & Company Ltd, New Delhi-110055.
- Ponnuswami, V., Padmadevi, K. and Muthu, S. K. 2012. Botany of Horticultural Crops. Narendra Publishing House, Delhi-110006.
- Singh, G. 2004. Plant Systematics: An Integrated Approach. Science Publishers.
- Spichiger, R.E., Savolainen, V., Figeat, M. and Jeanmond, D. 2004. Systematic Botany of Flowering Plants, 2nd Edition. Enfield, New Hampshire Science Publishers.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PS -3	PSO-4
CO-1	2	1	2	1	-	1	1	1	1	-	1	1	-	1	-	1
CO-2	1	1	1	2	1	2	-	2	1	1	2	-	-	2	-	3
CO-3	2	2	2	1	-	1	-	1	2	3	1	-	2	1	-	1
CO-4	1	1	1	1	-	1	1	1	1	-	1	1	-	1	-	-
CO-5	2	1	1	2	1	2	2	2	1	1	2	2	1	2	1	1
CO-6	1	2	1	1	3	1	-	1	-	3	1	2	2	-	2	1
Average PO	1.5	1.3	1.3	1.3	1.6	1.3	1.3	1.3	1.2	2.0	1.3	1.5	1.6	1.4	1.5	1.4

**Semester – II**

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-201	Credit	3(2+1)
Year/Sem	1/II	L-T-P	2-0-1
Course Name	<b>Advances in Floriculture and Landscaping</b>		

**Course Objectives:**

1. To educate about the principles and practices of landscaping and ornamental gardening.
2. To develop the understanding of Landscaping principles, planning and designing, landscaping public buildings, educational institutions, factories, historical places.
3. To develop ability for Bio-aesthetic planning, bonsai culture, flower forcing, role of colour in floriculture, exhibition, post harvest management.
4. To educate about advanced production technology of Rose, Gladiolus, Carnation, Tuberose, Marigold, etc.

**UNIT I (Total Topics - 6 and Hrs -6)**

History, importance and scope, problems and prospects, styles of gardening, formal garden and its important parts.

**UNIT II (Total Topics - 8 and Hrs -8)**

Landscaping- general principles, planning and designing, important elements, landscaping public buildings, educational institutions, factories, historical places.

**UNIT- III (Total Topics - 8 and Hrs -8)**

Bio-aesthetic planning, bonsai culture, flower forcing, role of colour in floriculture, exhibition, post harvest management.

**UNIT-IV (Total Topics - 8 and Hrs -8)**

Origin and distribution, area and production, taxonomy and morphological features, classification and description of some important cultivars, propagation, special practices and problems, use of bio regulators: Rose, Gladiolus, Carnation, Tuberose, Marigold, Gerbera, Chrysanthemum, Dahlia Bougainvillea, Jasmines

**Practical (Experiments- 8 and Hrs -16)**

- Identification of ornamental species
- Preparation of bonsai
- Use of bioregulators, judging, practice to conserve the life of cut flowers, morphological features of some ornamental plants, wintering in roses
- Preparation of shrubbery and herbaceous borders,
- Propagation techniques, planning and layout for a garden
- Cost of cultivation of commercial flowers,
- Visit to Ornamental Gardens.

**Course Outcomes (COs):**

- CO1: Recall principles and practices of landscaping and ornamental gardening.  
 CO2: Summarize principles, planning and designing of landscaping.  
 CO3: Prepare Bio-aesthetic planning, bonsai culture, flower forcing.  
 CO4: Explain advanced production technology of cut flowers.  
 CO5: Capable of managing an open field floriculture unit from planting to harvest.  
 CO6: Knowledge on advanced production technologies in growing flower crops.

**Suggested readings:**

- Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana.
- Bhattacharjee, S.K. 2006. Advances in Ornamental Horticulture (Vol. 1 to 6). Pointer Publication.
- Bhattacharjee, S.K. and De, L.C. 2003. Advanced Commercial Floriculture. Aavishkar Publishers, Jaipur.
- Bose, T. K., Yadav, L. P., Patil, P., Das, P. and Sarthy, V. A. P. 2003. Commercial Flowers. Naya Udyog.
- Bose, T.K., Maiti, R.G., Dhua, R.S. and Das, P. 1999. Floriculture and Landscaping. Naya Prokash.
- Choudhary, D. and Mehta, A. 2010. Flower Crops Cultivation and Management. Oxford Book Company, Jaipur.
- Kumari, V. 2008. Floriculture in India. Publ. Agency.
- Laurie, A. and Victor, H.R. 2001. Floriculture-: Fundamentals and Practices. Agorbios.
- Nambisan, K.M.P. 1992. Design Elements of Landscape Gardening. Oxford and IBH.
- Randhawa, G.S. and Mukhopadhyay, A. 2004. Floriculture in India. Allied Publishers Pvt. Ltd.
- Sabina, G.T. and Peter, K.V. 2008. Ornamental Plants for Gardens. New India Publ. Agency.
- Sheela, V. L. 2008. Flower for Trade. New India Publishing Agency, New Delhi.
- Singh, K. 2006. Flower Crops, Cultivation and Management. New India publishing agency, New Delhi.
- Woodrow, M.G. 1999. Gardening in India. Biotech Books.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	1	1	1	1	-	1	1	2	1	-	1	1	-	1	1	1
CO-2	3	1	1	2	1	2	-	1	1	1	1	2	-	2	1	3
CO-3	1	2	2	1	-	1	-	2	2	3	2	1	2	1	2	1
CO-4	-	1	1	1	-	1	1	1	1	-	1	1	-	1	1	-
CO-5	1	-	1	1	2	1	1	2	1	-	1	1	1	1	1	1
CO-6	1	1	2	1	1	2	1	1	1	1	1	2	2	2	3	2
Average	1.16	1.2	1.3	1.3	1.3	1.3	1.0	1.5	1.3	1.6	1.3	1.3	1.6	1.33	1.3	1.6

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-202	Credit	3(2+1)
Year/Sem	1/II	L-T-P	2-0-1
Course Name	<b>Advances in Breeding of Vegetable Crops</b>		

**Course Objectives:**

1. To impart knowledge on the recent research trends and advances in breeding of vegetable crops.
2. To study about breeding objectives, trends and recent advances in vegetable breeding.
3. To acquaint with the meaning of conventional breeding methods.
4. To learn about heterosis breeding for specific purposes like productivity, resistance to biotic and abiotic stresses and processing.

**UNIT I (Total Topics - 6 and Hrs -6)**

History, principles, problems and prospects of vegetable improvement. Biodiversity and conservation.

**UNIT II (Total Topics - 8 and Hrs -8)**

Introduction, selection including clonal selection and hybridization, mutation breeding, polyploidy and heterosis breeding for specific purposes like productivity, resistance to biotic and abiotic stresses and processing.

**UNIT- III (Total Topics - 8 and Hrs -8)**

Recent advances in breeding including biotechnological approaches.

**UNIT-IV (Total Topics - 8 and Hrs -8)**

Cytogenetics, breeding objectives, inheritance, early achievement and advances made in the following vegetables:

Solanaceous, cole crops, legumes, bulb crops, root vegetables, tuber crops, leafy vegetables and cucurbits.

**Practical (Experiments- 7 and Hrs -14)**

- Floral biology, pollination mechanism, selfing and crossing procedures
- Hybridization techniques working out phenotypic and genotypic variability, pcv, gcv heritability, genetic advance
- Preparation and use of chemicals and physical mutagens, polyploidy breeding, techniques of F1 hybrid seed production
- Maintenance of breeding record
- Visit to breeding blocks

**Course Outcomes (COs):**

CO1: Memorize principles and objectives of vegetable crops breeding.

CO2: Understand recent research trends and advances in vegetable breeding.

CO3: Determine conventional and modern breeding methods

CO4: Description of various vegetable varieties grown in India.

CO5: Apply advance techniques of breeding in vegetable crops.

CO6: Discuss breeding techniques and achievements in vegetable crops.

**Suggested readings:**

- Bassett, M. 1986. Breeding Vegetable Crops. Springer, US.
- Dhaliwal, M.S. 2009. Vegetable Seed Production & Hybrid Technology. Kalyani Publishers, Ludhiana.
- Dhaliwal, M.S. 2012. Techniques of Developing Hybrids in Vegetable Crops. Agrobios, Jodhpur.
- Kallo, G. 1998. Vegetable Breeding (Vol. I to IV). CRC Press, Florida.
- Kalloo, G. and Bergh, B.O. 1993. Genetic Improvement of Vegetable Crops. Pergamon Press.

- Peter, K. V. 2009. Genetics and Breeding of Vegetables. Directorate of Information and Publications of Agriculture, ICAR.
- Ram, H.H. 2013. Vegetable Breeding: Principle and Practices. Kalyani Publishers, Ludhiana.
- Singh, H.P. 2009. Vegetable Varieties of India. Studium Press (India) Pvt Ltd., New Delhi.
- Singh, P.K. 2005. Hybrid Vegetable Development. CRC Press, Florida.
- Swaroop, V. 2014. Vegetable Science & Technology in India. Kalyani Publishers, Ludhiana.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	1	2	-	-		-	-	-	-		-	2	2	-	-
CO-2	-	2	1	-	-	2	-	-	-	-		-	-	1	-	-
CO-3	1	1	2	-	-	1	-	-	-	-	1	-	2	-	-	2
CO-4	1	1	1	1	-	1	-	2	-	2	1	1	-	-	-	-
CO-5	-	-	-	-	3	-	3	2	-	-	2	2	-	2	3	2
CO-6	-	-	-	2	2	-	1	-	2	3	2	3	-	-	2	-
Average	1.3	1.25	1.5	1.5	2.5	1.3	2.0	2.0	2.0	2.5	1.5	2.0	2.0	1.5	2.5	2.0

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-203	Credit	3(2+1)
Year/Sem	1/II	L-T-P	2-0-1
Course Name	<b>Biotechnology of Horticultural Crops</b>		

**Course Objectives:**

1. To understand with the principles, theoretical aspects and developing skills in biotechnology of horticultural crops.
2. To educate about bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on tissue culture.
3. To study about organ culture, somatic hybrids and cybrids, cryopreservation, rapid clonal propagation.
4. To acquaint with the genetic engineering in horticultural crops.

**UNIT I (Total Topics - 5 and Hrs -5)**

Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

**UNIT II (Total Topics – 5 and Hrs -5)**

Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.

**UNIT- III (Total Topics - 5 and Hrs -5)**

Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants.

**UNIT-IV (Total Topics - 8 and Hrs -8)**

Physiology of hardening - hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.

**UNIT-V (Total Topics - 7 and Hrs -7)**

Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering in horticulture crops, use of molecular markers. *In vitro* selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

**Practical (Experiments- 7 and Hrs -14)**

- An exposure to low cost, commercial and homestead tissue culture laboratories
- Media preparation, inoculation of explants for clonal propagation
- Callus induction and culture, regeneration of plantlets from callus, sub-culturing, techniques on anther, ovule, embryo culture, somaclonal variation, *in vitro* mutant selection against abiotic stress, protoplast culture, fusion technique
- Development of protocols for mass multiplication
- Project development for establishment of commercial tissue culture laboratory.

**Course Outcomes (COs):**

CO1: Define the principles and theoretical aspects of biotechnology of horticultural crops.

CO2: Compare and estimate physical, chemical factors and growth regulators on tissue culture.

CO3: Prepare organ culture, somatic hybrids and cybrid, cryopreservation, rapid clonal propagation in horticultural crops.

CO4: Explain achievements of biotechnology in horticulture field.

CO5: Able to demonstrate different techniques in biotechnology.

CO6: Able to prepare a proposal for establishment of a tissue culture laboratory.

**Suggested readings:**

- Bajaj, Y.P.S. 1989. Biotechnology in Agriculture and Forestry (Vol. V) Fruits. Springer.
- Brown, T.A. 2001. Gene Cloning and DNA Analysis and Introduction. Blackwell Publ.
- Chopra, V.L. and Nasim, A. 1990. Genetic Engineering and Biotechnology-Concepts, Methods and Applications. Oxford and IBH.
- Gorden, H and Rubsell, S. 1960. Hormones and Cell Culture. AB Book Publ.
- Keshavachandran, R and Peter, K.V. 2008. Plant Biotechnology: Tissue Culture and Gene Transfer. Orient and Longman (Universal Press).
- Keshavachandran, R., Nazeem, P.A., Girija, D., John, P.S. and Peter, K.V. 2007. Recent Trends in Biotechnology of Horticultural Crops (Vols. I & II). New India Publ. Agency.
- Parthasarathy, V.A., Bose, T.K., Deka, P.C., Das, P., Mitra, S.K. and Mohandas, S. 2001. Biotechnology of Horticultural Crops (Vols. I to III). Naya Prokash.
- Pierik, R.L.M. 1987. In vitro Culture of Higher Plants. Martinus Nijhoff Publ.
- Skoog, F. and Miller, C.O. 1957. Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro. Symp. Soc. Exp. Biol.11:118-131.
- Vasil, T.K., Vasi, M., While, D.N.R. and Bery, H.R. 1979. Somatic Hybridization and Genetic Manipulation in Plants: Plants Regulation and World Agricultural. Planum Press.
- Williamson, R. 1981-86. Genetic Engineering (Vol. I to V). Academic Press.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	1	2	-	-		-	-	-	-	1		2	2	-	-
CO-2	-	2	1	-	-	2	-	-	-	-	-	-	-	1	-	-
CO-3	1	1	2	-	-	1	2	1	-	-	2	-	2	-	-	2
CO-4	1	1	1	1	2	1	-	2	-	2	-	1	-	-	-	-
CO-5	-	-	-	1	2	-	1	1	1	-	-	-	-	-	-	-
CO-6	-	-	-	1	-	-	1	-	2	2	-	2	-	-	-	-
Average	1.3	1.25	1.5	1.0	2.0	1.3	2.0	2.0	1.5	2.0	1.5	1.5	2.0	1.5	-	2.0

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-204	Credit	2(2+0)
Year/Sem	1/II	L-T-P	2-0-0
Course Name	<b>GAP for Horticultural Crops</b>		

**Course Objectives:**

1. To develop understanding of organic horticulture production system including Good Agricultural Practices (GAP).
2. To educate about management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection.
3. To impart knowledge of on farm processing, storage, energy and waste management, human health, welfare, safety, wild life benefits.
4. To acquaint with institutions involved in GAP certification. Indian agencies, EUREPGAP (European Retail Producers Group- Good Agricultural Practices), EUREP.

**UNIT I (Total Topics - 4 and Hrs -4)**

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

**UNIT II (Total Topics - 6 and Hrs -6)**

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 (Total Topics - 5 and Hrs -5)**

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

**UNIT-IV (Total Topics - 7 and Hrs -7)**

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

**UNIT-V (Total Topics - 8 and Hrs -8)**

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

**Practical (Hrs)- NA**

**Course Outcomes (COs):**

- CO1: Define organic horticulture production system including GAP.  
 CO2: Understand IPM, INM, IWM, crop production and protection.  
 CO3: Impart knowledge of on farm processing, storage, energy and waste management.  
 CO4: Analyze Good Agricultural Practices and their certification for fruit crops.  
 CO5: Analyze Good Agricultural Practices and their certification for vegetable & MAP crop.  
 CO6: Analyze Good Agricultural Practices and their certification for postharvest technology.

**Suggested readings:**

- Singh, A.K. 2009. Good Agricultural Practices: Food Safety for Fresh Produce. Studium Press (India) Pvt.ltd.
- Singh, S. and Saxena A.K. 2020. Good Agricultural Practices for Horticultural Crops. Akinik publication, New Delhi.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	1	2	-	-	-	-	-	-	-	1	-	2	2	-	-
CO-2	-	2	1	-	1	2	-	-	-	-	-	-	-	1	-	-
CO-3	1	1	2	-	-	1	2	3	-	-	2	1	2	-	-	1
CO-4	1	1	1	1	-	1	-	-	2	1	-	2	-	-	1	1
CO-5	-	-	-	2	2	-	-	-	-	2	-	-	-	-	1	1
CO-6	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-
Average	1.3	1.25	1.5	1.5	1.5	1.3	2.0	2.5	2.0	1.5	1.5	1.5	2.0	1.5	1.0	1.0

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-205	Credit	3(2+1)
Year/Sem	1/II	L-T-P	2-0-1
Course Name	<b>Advances in Post- Harvest Technology and Management of Fruits and Vegetables</b>		

**Course Objectives:**

1. To understand the principles and methods of postharvest management of horticultural crops.
2. To study about physiology and biochemical change during ripening. Post harvest loss and their control.
3. To acquaint with the with principles and manufacturing of canning, jam, jelly, marmalade, unfermented beverages, pickles, chutneys, sauces, ketchup, soup, Vinegar and frozen products.
4. To aware about principles and guidelines for establishing processing unit. Government policies, regulation and specifications for fresh and processed products.

**UNIT I (Total Topics - 6 and Hrs -6)**

Introduction, post harvest physio-biochemical changes; causes of post harvest losses, control of post harvest losses- proper cultural operations, pre-storage treatments, transportation, storage, environmental control, ionizing radiation, post harvest chemical treatments, storage of fresh fruits and vegetables, factor affecting storage quality, storage disorders, marketing of fruits and vegetables and their products.

**UNIT II (Total Topics - 3 and Hrs -3)**

History, objectives and scope of fruit and vegetable preservation, spoilage of fruits and vegetables, principles of preservation- temporary and permanent; vitamins and other nutrients in preserved products, food additives and their use in preservation. Principles and guidelines for establishing processing unit.

**UNIT- III (Total Topics - 3 and Hrs -3)**

Containers: Types, merits and demerits, composition and manufacturing of tin and glass containers, failures in glass containers, general principles and procedures of canning and bottling, spoilage of canned products.

**UNIT-IV (Total Topics - 4 and Hrs -4)**

Principles and methods of jam, jelly and marmalade; theories of jelly formation, failures of jelly; unfermented fruit and vegetable beverages, juice extraction equipments, general methods of preparation and preservation, preservation of unfermented beverages.

**UNIT-V (Total Topics - 4 and Hrs -4)**

General methods of making preserve and candy from some suitable fruits and vegetables, preparation of pickles, chutneys, sauces, ketchup, soup and cocktail from suitable fruits and vegetables, causes of spoilage.

**UNIT-VI (Total Topics - 5 and Hrs -5)**

Vinegar- quality standards, types, material processing and fermentation, methods of preparation, post-production processes, spoilage; pectin preparation. Sun drying- merits and demerits, procedure; mechanical dehydration of fruits and vegetables, home and commercial dehydrators, packing and storage.

**UNIT-VII (Total Topics - 5 and Hrs -5)**

Preservation by freezing- objectives, freezing and growth of micro-organisms, freezing process, storage of frozen products; exposure on preservation by radiation. Government policies, regulation and specifications for fresh and processed products.

**Practical (Experiments- 6 and Hrs -12)**

- Identification of equipments used in preservation
- Canning of fruits and vegetables, cut out test for canned products
- Preparation of jam, jelly, squash, juice, preserve, chutney, ketchup, sauce, pickle
- Dehydration of potato, estimation of acidity, vitamin C, sugar, juice content and T.S.S.
- Visit to processing factories.

**Course Outcomes (COs):**

CO1: Memorize principles of postharvest management of horticultural crops.

CO2: Understand Physiology and biochemical change during ripening.

CO3; Prepare jam, jelly, marmalade, unfermented beverages, pickles, and chutneys, sauces, ketchup, soup, Vinegar and frozen products.

CO4: Categorize guidelines for establishing processing unit.

CO5: Understand technologies of post-harvest technology and its role in providing better quality produce to the consumer

CO6: Demonstrate different methods of processing of fruits and vegetables.

**Suggested readings:**

- Battacharjee, S. K. and De, L. C. 2005. Post Harvest Technology of Flowers and Ornamentals Plants. Pooner Publisher, Jaipur, India.
- Chadha, K. L. and Kalloo, G. 1993. Advances in Horticulture (Vol. 4 to 10). MPH, New Delhi.
- Fellows, P. J. 1998. Food Processing Technology: Principles and Practices. Ellis Horwood.
- Hulme, A.C. 1970. Food Science & Technology- A Series of Monograph: The Biochemistry of Fruits and their Products (Vol. 1). Academic Press London & New York.
- Jacob, J. P. 2008. A Handbook on Post Harvest Management of Fruits and Vegetables. Daya Publishing House, Delhi.
- Kitinoja, L. and Kader, A. A. 2003. Small-Scale Postharvest Handling practice: A Manual for Horticulture Crops (4th ed.). US Davis, PHT Research and information Center.
- Mitra, S. K. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CAB International.
- Pruthi, J. S. 2001. Minor Spices and Condiments – Crop Managements and Post Harvest Technology. ICAR, New Delhi.
- Ranganna, S. 2017. Handbook of Analysis and Quality Control for Fruit and Vegetable Products (2nd Edt.). McGraw Hill Education.
- Saraswathy, S. 2008. Post harvest Management of Horticultural Crops. Agribios (India).
- Shanmugavelu, K. G., Kumar, N. and Peter, K.V. 2002. Production Technology of Spices and Plantation Crops. Agrobios (India).
- Sharma, N. and Mashkoor, A. M. 1998. Post Harvest Diseases of Horticultural Perishables. International Book Distributing Co., Lucknow.
- Srivastava, R.P. and Sanjeev, K. 2017. Fruit and Vegetable Preservation: Principles and Practices. CBS Publishers & Distributors.
- Stanley, J. K. 1998. Post Harvest Physiology of Perishable Plant Products. CBS, New Delhi.
- Thomposon, A. K. 1996. Post Harvest Technology of Fruits and Vegetables. Blackwell Science.
- Verma, L. R. and Joshi, V. K. 2000. Post Harvest Technology of Fruits and Vegetables (Vol. I & II). Indus Publishing Co., New Delhi
- Wiils, M. G. and Graham, J. 2007. Post Harvest- An Introduction to the Physiology and Handling of Fruits, Vegetables and ornamentals. Cab International

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	2	2	-	-	-	-	-	-	-	2	-	-	2	-	-
CO-2	1	2	1	-	-	2	-	-	-	-	-	2	-	1	-	-
CO-3	1	1	2	-	-	1	2	-	-	-	2	-	2	3	-	1
CO-4	1	1	1	1	-	1	-	2	2	-	-	2	-	-	1	-
CO-5	-	-	-	2	2	-	2	2		2	-	-	-	-	1	1
CO-6	-	-	-	-	1	-	-	-	3		-	-	2	-	1	1
Average	1.25	1.5	1.5	1.5	1.5	1.3	2.0	2.0	2.5	2.0	2.0	2.0	2.0	2.0	1.0	1.0

**Semester – III**

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-301	Credit	3(2+1)
Year/Sem	2nd/III	L-T-P	2-0-1
Course Name	<b>Protected Cultivation of Horticultural Crops</b>		
<b>Course Objectives:</b>			
<ol style="list-style-type: none"> <li>1. To acquaint with the principle, theoretical aspects and developing skills in protected cultivation of horticultural crops.</li> <li>2. To study about environment control in protected structures.</li> <li>3. To develop the understandings of growing media, sterilization, soilless cultivation, hydroponics and aeroponics.</li> <li>4. To develop the skills of Protected cultivation of horticultural crops rose, carnation, gerbera, capsicum, tomatoes, exotic vegetables.</li> </ol>			
<b>UNIT I (Total Topics - 7 and Hrs -7)</b>			
Introduction, history, present status, importance, problems and prospects of protected cultivation. Types and designs of protected structures and their management.			
<b>UNIT II (Total Topics - 8 and Hrs -8)</b>			
Environment control in protected structures. Growing media and sterilization. Soilless cultivation, hydroponics and aeroponics, irrigation and fertigation. Integrated insect pest and disease management.			
<b>UNIT- III (Total Topics - 8 and Hrs -8)</b>			
Vegetable seedlings production under protection. Protected cultivation of horticultural crops (media, bed preparation, varieties, planting, irrigation and fertigation, harvesting, specific operation for different crops and economics) like; rose, carnation, gerbera, orchids, anthurium, liliun, chrysanthemum, capsicum, tomatoes, exotic vegetables, potted ornamental plants.			
<b>UNIT-IV (Total Topics - 7 and Hrs -7)</b>			
Post harvest management of flowers and vegetable (sorting, grading, packing, storage, transportation and marketing).			
<b>Practical (Experiments- 7 and Hrs -14)</b>			
<ul style="list-style-type: none"> <li>• Study of different protected structures, cladding materials used, installation and their management.</li> <li>• Study of environment, control devices used in protected structures and measurement of temperature, RH, light and CO<sub>2</sub>.</li> <li>• Study of growing media and sterilization.</li> <li>• Study of irrigation and fertigation system and their management.</li> <li>• Soilless cultivation: Hydroponics and aeroponics.</li> <li>• Vegetable seedlings production under protection.</li> <li>• Visit to commercial green house projects</li> </ul>			
<b>Course Outcomes (COs):</b>			
CO1: Define the principle of protected cultivation of horticultural crops.			
CO2: Understand and summarize protected structures, Growing media, soilless cultivation, hydroponics and aeroponics.			

CO3: Implement protected cultivation of horticultural crops and exotic vegetables.

CO4: Apply protected cultivation of fruit crops.

CO5: Demonstrate protected cultivation of vegetable crops.

CO6: Apply protected cultivation of flowers.

**Suggested readings:**

- Aldrich, R.A. and Bartok, J.W. 1994. Green House Engineering. Cornell University, Ithaca, New York.
- Bose, T.K. and Yadav, L.P. 1989. Commercial Flowers. Naya prokash.
- Castilla, N. 2012. Greenhouse Technology and Management (2nd Edt.). CABI.
- Kumar, T. P., Suma, B., Bhaskar, J. and Satheson, K.N. 2008. Management of Horticultural Crops. New India Publishing Agency, New Delhi.
- Nelson, P.V. 1978. Green House Operation and Management. Reston Publ. Co.
- Nelson, P.V. 1991. Green House Operation and Management. Bali Publ.
- Parvatha, R.P. 2003. Protected Cultivation. Springer Publications, USA.
- Parvatha, R.P. 2011. Sustainable Crop Protection Under Protected Cultivation. Springer Publications, USA.
- Prasad, S. 2005. Greenhouse Management for Horticultural Crops. Agrobios, Jodhpur.
- Singh, B. 2006. Protected Cultivation of Vegetable Crops. Kalyani Publishers, Ludhiana.
- Singh, B. 2014. Advances in Protected Cultivation. New India Publishing Agency, New Delhi.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
CO-1	2	1	1	1	-	2	1	1	1	-	2	1	2	1	1	1
CO-2	1	2	1	-	1	1	1	1	-	1	1	1	1	2	1	1
CO-3	1	-	-	1	1	-	-	1	1	1	-	-	1	-	-	1
CO-4	1	1	1	1	-	1	2	2	1	1	1	2	1	1	2	-
CO-5	1	-	-	1	1	1	1	1	1	-	1	1	1	1	-	1
CO-6	1	2	1	1	1	2	2	1	1	1	2	2	1	1	2	-
Average	1.16	1.5	1.0	1.0	1.0	1.4	1.4	1.16	1.0	1.0	1.4	1.4	1.16	1.2	1.5	1.0

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-302	Credit	3(2+1)
Year/Sem	2nd/III	L-T-P	2-0-1
Course Name	<b>Advances in Growth and Development of Horticultural Crops</b>		

**Course Objectives:**

1. To acquaint with the physiology of growth and development of horticultural crops.
2. To develop the skills in applications of growth promoters, inhibitors, morphactins, antitranspirants, etc. for various purposes in horticultural crops.
3. To acquire the skill about Physiology and bio-chemistry of seed germination, dormancy, pollination, fertilization and fruit set, ripening and seed development; parthenocarpy.
4. To Aware about impact of pruning and training, chemical manipulations in horticultural crops.

**UNIT I (Total Topics - 2 and Hrs -2)**

Growth and development- definition, parameters of growth and development, growth dynamics/analysis and its importance.

**UNIT II (Total Topics - 5 and Hrs -5)**

Assimilate partitioning during growth and development; environmental impact on growth and development; Morphogenesis; Role of light, temperature and photoperiod on growth, development of underground parts.

**UNIT III (Total Topics - 3 and Hrs -3)**

Flowering and sex expression in horticultural crops; influence of water and mineral nutrition during growth and development; apical dominance.

**UNIT- IV (Total Topics - 6 and Hrs -6)**

Auxins, gibberellins, cytokinins and abscissic acid; biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene; role and mode of action of brassinosteroids, growth inhibitors, morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants.

**UNIT- V (Total Topics - 3 and Hrs -3)**

Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in horticultural crops.

**UNIT-VI (Total Topics - 7 and Hrs -7)**

Physiology and bio-chemistry of seed germination. Dormancy: physiology, causes, method of breaking etc.; bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, flower and fruit drop, fruit growth, ripening and seed development; parthenocarpy.

**UNIT-VII (Total Topics - 4 and Hrs -4)**

Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

**Practical (Experiments- 7 and Hrs -14)**

- Techniques of growth analysis; evaluation of photosynthetic efficiency; study of growth regulator.
- Preparation of solutions of plant growth substances and their application.
- Understanding ripening phenomenon in fruits and vegetables.

- Understanding stress impact on growth and development.
- Visit to commercial green house projects

**Course Outcomes (COs):**

CO1: Define growth and development of horticultural crops.  
 CO2: Estimate and compare applications of growth promoters, inhibitors, morphactins, antitranspirants.  
 CO3: Examine physiology of seed germination, dormancy, pollination, fertilization and fruit set, ripening and seed development  
 CO4: Distinguish pruning and training in horticultural crops.  
 CO5: Illustrate the mechanism of plant dormancy and plant physiology in horticultural crops.  
 CO6: Apply plant growth regulators in horticultural crops for increasing quality production.

**Suggested readings:**

- Acquaah, G. 2013. Principles and Practices of Horticulture. PHI Learning Pvt. Ltd., New Delhi.
- Basra, A. S. 2004. Plant Growth Regulators in Agriculture & Horticulture. Hawarth Press, New York.
- Basra, A.S. 2016. Plant Growth Regulators in Agriculture and Horticulture: Their Role & Commercial Uses. CRC Press.
- Bleasdale, J.K.A. 1983. Plant Physiology in Relation to Horticulture. Avi Publishing Co. Inc.
- Delvin, R. M. 1986. Plant Physiology. CBS, Delhi.
- Durna, E. E. 2014. Principles of Horticultural Physiology. CABI, UK.
- Jacobs, W. P. 1979. Plant Hormones and Plant Development. Cambridge Univ. London.
- Noggle, G.R and Fritz, T.G.1944. Introductory Plant Physiology. Prentice Hall India Pvt. Ltd., New Delhi.
- Pandey, S.N. and Sinha, B.K. 2005. Plant Physiology. Vikas Publication House Pvt. Ltd.
- Rajendran, C., Ramamoorthy, K. and Hepziba, S. J. 2009 Nutritional and Physiological Disorders in Crop Plants. Scientific Pub.
- Richard, N. A. 2004. Plant Growth Substances. CBS, New Delhi.
- Salisbury, F.B. and Rose, C.W. 2017. Plant Physiology. CBS publishers and Distributors, Delhi.
- Sandhu, M.K. 2014. Plant Propagation. New Age International Publishers, Lucknow.
- Srivastava, H.N. 2012. Plant Physiology. Pradeep publishing, Jalandhar.
- Taiz, L. 2010. Plant Physiology. Sinaur, USA.
- Taiz, L. and Zeiger, E. 2010. Plant Physiology (5th Edition). Sinauer Associates, Inc.
- Zeiger. 2003. Plant Physiology. Panima, New Delhi.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	1	1	3	-	1	1	-	-	1	1	-	-	1	1	-
CO-2	1	1	1	2	1	-	1	1	-	1	1	-	-	1	1	-
CO-3	2	1	1	3	1	1	1	2	1	1	1	2	-	1	1	2
CO-4	1	1	-	1	-	-	1	1	1	-	1	1	-	1	-	1
CO-5	2	1	1	3	1	1	1	2	2	1	1	1	1	1	1	2
CO-6	1	2	-	1	1	2	1	1	1	-	1	1	1	1	-	1
Average	1.5	1.16	1.0	2.2	1.0	1.25	1.0	1.4	1.25	1.0	1.0	1.25	1.0	1.0	1.0	1.5

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-303	Credit	3(2+1)
Year/Sem	2nd/III	L-T-P	2-0-1
Course Name	<b>Advances in Pomology</b>		

**Course Objectives:**

1. To impart comprehensive knowledge to the students on cultural and management practices for growing tropical and subtropical fruits (mango, banana, citrus, grapes, litchi, pomegranate, etc.),
2. To acquire knowledge about temperate fruits (apple, pear, stone fruits, kiwifruit, etc.), nuts (walnut, pecan, etc.) and minor fruits.
3. To study about commercial varieties classification and description of important cultivars.
4. To develop the understanding of planting system, propagation method, training and pruning, nutrition, bearing habit, pollination and fruit set, use of bioregulators, special problems and physiological disorders.

**UNIT I (Total Topics - 3 and Hrs -3)**

Introduction, prospects and scope, constraints of fruit industry.

**UNIT II (Total Topics - 7 and Hrs -7)**

Origin and distribution, area and production, taxonomy, classification and description of important cultivars, planting system, propagation method, training and pruning, nutrition, bearing habit, pollination and fruit set, use of bioregulators, special problems and physiological disorders in the production of the following fruits:

Tropical and subtropical fruits- Mango, Citrus fruits, Banana, Guava, Grape, Litchi, Papaya, Pine-apple, Jack-fruit.

**UNIT III (Total Topics - 8 and Hrs -8)**

Minor fruits- Ber, Aonla, Pomegranate, Loquat, Sapota, Phalsa, Bael, Karonda,

**UNIT- IV (Total Topics - 12 and Hrs -12)**

Temperate fruits: Pome Fruits- Apple and Pear , Stone Fruits- Peach, Plum, Apricot, Cherry and Almond, Nut Fruits- Walnut, Pecannut, Hazelnut and Pistachio etc., Berries- Strawberry, Raspberry, Gooseberry Kiwi fruit.

**Practical (Experiments- 7 and Hrs -14)**

- Identification and morphological features of important cultivars of fruit crops
- Preparation of layout for orchards
- Practice of commercial propagation techniques
- Pruning and training system, malady diagnosis, use of bioregulators
- Visit to tropical, subtropical and temperate Fruit Research Centres

**Course Outcomes (COs):**

CO1: Outline and memorize cultural and management practices for growing tropical and subtropical fruits

CO2: Categorize temperate fruits, nuts and minor fruits.

CO3: Execute propagation, training and pruning of fruits.

CO4: Apply the knowledge of minor and temperate fruits.

CO5: Appreciate the research advancements made in the fruit crops.

CO6: Able to recommend suitable package of practices for enhanced production of fruit crops.

**Suggested readings:**

- Bose, T.K., Mitra S.K. and Sanyal, D. 2001. Fruits- Tropical and Subtropical. Naya Udyog.
- Bose, T.K., Mitra, S.K. and Sanyol, D. 2002. Fruits of India-Tropical and sub-Tropical. Naya Udyog.
- Chadha, K.L. and Pareek, O.P., 1996. Advance in Horticulture (Vol. II & VIII) Malhotra Publ. House.
- Chadha, K.L. and Pareek, O.P. 1996. Advances in Horticulture (Vols. III). Malhotra Publ. House.
- Misra, K.K. 2014. Textbook of Advance Pomology. Biotech
- Nakasone, H.Y. and Puul, R.E. 1998. Tropical Fruits. CABI.
- Peter, K.V. 2008. Basic of Horticulture. New India Publ. Agency.
- Pradeep K.T., Suma B. J. and Satheesan, K.N. 2008. Management of Horticultural Crops (Parts I & II). New India Publ. Agency.
- Radha, T. and Mathew, L. 2007. Fruit Crops. New India Publ. Agency.
- Singh, H.P., Negi, J.P. and Samuel, J.C. 2002. Approaches for Sustainable Development of Horticulture. National Horticultural Board.
- Singh, H.P., Singh, G., Samuel, J.C. and Pathak, R.K. 2003. Precision Farming in Horticulture NCPAH, DAC/ PFDC, CISH, Lucknow.
- Westwood, M. N. 1988. Temperate-zone Pomology. Timber Press.
- Westwood, M.N. 2009. Temperate-Zone Pomology: Physiology and Culture, Third Edition. Timber Press.

**Articulated Attainment**

COs/POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	1	1	1	1	1	1	2	1	-	1	1	-	1	-	1
CO-2	1	1	1	2	1	2	-	1	1	1	2	-	-	2	-	1
CO-3	2	2	2	1	1	1	1	2	2	3	1	-	2	1	-	1
CO-4	1	1	1	3	1	1	1	1	1	-	1	1	-	1	-	-
CO-5	1	1	-	2	1	2	1	1	1	1	2	1	2	2	1	1
CO-6	1	2	1	-	2	1	1	1	2	3	1	-	1	1	1	1
Average	1.3	1.3	1.2	1.8	1.16	1.3	1.5	1.3	1.3	2.0	1.3	1.0	1.6	1.3	1.0	1.0

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHS-304	Credit	1(0+1)
Year/Sem	2nd/III	L-T-P	0-0-1
Course Name	<b>Master's Seminar</b>		

**Course Objectives:**

1. To acquaint with scientific terms, concepts and content preparation, etc.
2. To develop the ability to make power point and presentation.
3. To develop the ideas for using photographs and sketches in power point to give valuable information.
4. To develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

**UNIT (Hrs) - NA**

**Practical (Hrs-30)**

- A power point presentation on any topic chosen from the courses studied to be prepared and delivered to the group of faculty members/staff and students of department.
- Essential components of Presentation are: Organization of topic, Presentation of data.
- Oral presentation, Delivery, language, explanation of figures, Ability to grasp and understand the subject, Depth of understanding the topic.

**Course Outcomes (COs):**

- CO1. Acquaint with scientific terms, concepts and content preparation, etc.  
 CO2. Outline and summarize presentation.  
 CO3. Present and implement photographs and sketches in power point to give valuable information.  
 CO4. Correlate research proposal or synopsis, report, manuscripts/article and publications.  
 CO5. Debate on the concern topic.  
 CO6. Prepare research paper, articles and newsletters.

**Suggested readings:**

- Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	1	2	-	-	-	-	-	-	-			-	-	-	-
CO-2	-	2	1	-	-	2	-	-	-	-		2	-	-	-	-
CO-3	1	1	2	-	-	1	-	-	2	-	2	1	-	-	-	-
CO-4	1	1	1	1	-	1	-	-	1	-	1	1	-	2	-	1
CO-5	-	-	-	-	1	-	2	2	1	3	1	-	3	1	2	-
CO-6	-	-	-	3	2	-	2	-	-	2	-	-	2	-	-	1
Average	1.3	1.25	1.5	2.0	1.5	1.3	2.0	2.0	1.3	2.5	1.3	1.3	2.5	1.5	2.0	1.0

**Semester – IV**

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHC-401	Credit	3(2+1)
Year/Sem	2nd/IV	L-T-P	2-0-1
Course Name	<b>Organic Horticulture</b>		

**Course Objectives:**

1. To acquaint with the principles, methods, merits and demerits of organic horticulture.
2. To study about systems, components of different organic inputs, role of biofertilizers, biodynamics and the recent developments in organic horticulture.
3. To familiarize with EM technology, HACCP, certification agencies involved at national and international levels.
4. To generate know-how the constraints in certification, export, IFOAM and global scenario of organic movement and post-harvest management of organic produce.

**UNIT I (Total Topics - 3 and Hrs -3)**

Organic horticulture – definition, synonyms and misnomers, principles, methods, merits and demerits.

**UNIT II (Total Topics - 4 and Hrs -4)**

Organic farming systems, components of organic horticultural systems, different organic inputs, their role in organic horticulture, role of biofertilizers, biodynamics and the recent developments.

**UNIT III (Total Topics - 8 and Hrs -8)**

EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement.

**UNIT- IV (Total Topics - 7 and Hrs -7)**

GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.

**UNIT- V (Total Topics - 8 and Hrs -8)**

Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, post-harvest management of organic produce.

**Practical (Experiments- 7 and Hrs -14)**

- Features of organic orchards, working out conversion plan
- Input analysis manures, nutrient status assessment of manures
- Biocomposting, biofertilizers and their application, panchagavya preparation and other
- Organic nutrients application, methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application, BD preparations and their role
- EM technology and products, biological/natural control of pests and diseases, soil solarization
- Framework for GAP, case studies, HACCP analysis, residue analysis in organic products, documentation for certification
- Visit to fields cultivated under organic practices

**Course Outcomes (COs):**

- CO1: Explain definition, merits and demerits of Organic horticulture  
 CO2: Summarize and relate organic horticulture with bio fertilizers and bio-dynamics.  
 CO3: Use and articulate EM technology, HACCP exercise, certification of organic products.  
 CO4: Analyse the global scenario of organic movement, post-harvest management of organic produce.  
 CO5: Able to recommend suitable organic package of practices for enhanced production of horticultural crops.  
 CO6: Able to establish various organic input production units.

**Suggested readings:**

- Claude, A., Vandana, S., Sultana, I., Vijaya, L., Korah, M. and Bernard, D. 2000. The Organic Farming Reader. Other Indian Press, Goa.
- Dahama, K. 2007. Organic Farming for Sustainable Agriculture. Agrobios (India), Jodhpur.
- Gaur, A.C., Neblakantan, S. and Dargan, K.S. 1984. Organic Manures. ICAR.
- Lampkin, N. and Ipswich. 1990. Organic Farming. Farming Press. London.
- Lampkin, N.H. and Padel, S. 1992. The Economic of Organic Farming: An International Perspective. CABI.
- Palaniappan and Annadural. 2008. Organic Farming: Theory and Practice. Scientific Publ.
- Palaniappan, S.P. and Annadurai, K. 2010. Organic Farming: Theory and Practice. Scientific Publishers, Jodhpur.
- Peter, K.V. 2008. Basis of Horticulture. New Indian Publ. Agency, New Delhi.
- Purshit, S.S. 2006. Trends in Organic Farming in India. Agros Bios (INDIA), Jodhpur.
- Rao, S. 1977. Soil Microorganism and Plant Growth. Oxford and IBH.
- Sathe, T. V. 2004. Vermiculture and Organic Farming. Daya Publishing House, New Delhi.
- Sharma, A. K. 2011. Handbook of Organic farming. Agrobios (India), Jodhpur.
- Thampan, P. K. 1995. Organic Agriculture. Peckay Tree Crops Development Foundation, Cochin, Kerala.
- Thapa, U. and Tripathy, P. 2006. Organic Farming in India: Problems and Prospects. Agrotech Publishing Agency, Udaipur.
- Veeresh, G.K. 2006. Organic Farming. Foundation Books, New Delhi.

**Articulated Attainment**

COs/ POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	1	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO-2	-	2	1	-	-	2	-	-	-	-	1	-	1	-	1	1
CO-3	1	1	2	-	1	1	1	1	1	-	2	-	1	1	1	1
CO-4	1	1	1	1	1	1	-	-	1	1	1	1	2	-	1	1
CO-5	1	1	1	1	1	1	1	1	-	2	-	1	-	2	-	-
CO-6	1	2	1	1	1	1	1	1	2	-	1	-	1	1	1	1
Average	1.2	1.3	1.3	1.0	1.0	1.2	1.0	1.0	1.3	1.5	1.4	1.0	1.25	1.33	1.0	1.0

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHT-402	Credit	20(0+20)
Year/Sem	2nd/IV	L-T-P	0-0-20
Course Name	<b>Master's Thesis</b>		

**Course Objectives:**

1. Aim of introducing thesis in M.Sc. (Ag.) Horticulture is to give the students preliminary exposure for conducting the research and presenting its findings systematically and scientifically in a manuscript shape.
2. To fulfill this goal, a specific topic for thesis research shall be assigned to M.Sc. student by the teacher(s)/supervisor(s) of the department, in the first semester.
3. The student will carry out the research for thesis under the respective supervisor(s) and finally present it in a book shape called thesis

**UNIT (Hrs) - NA**

**Practical (Hrs-40)**

- Synopsis, Research Work & Thesis work provides the students an excellent opportunity to develop analytical research and entrepreneurial skills, and knowledge through meaningful hands on experience, confidence in their ability to design and investigate the things.

**Course Outcomes (COs):**

- CO1. Remember scientific terms of research designing, citation and bibliography.  
 CO2. Summarize ethical dimensions of research work and knowledge to obtain appropriate approval.  
 CO3. Correlate scientific measurements, statistical calculations and analysis of data.  
 CO4. Explain research works, collection, classification, presentation and analysis of data.  
 CO5. Evaluate the treatments in experiments.  
 CO6. Prepare and Manage experimental fields.

**Suggested readings:**

- Kumar, R. 2014. Research Methodology: A Step-by-Step Guide for Beginners. 4<sup>th</sup> Edition. SAGE Publications Ltd.
- Parikh, M.N, Gogtay, N. 2009. ABC of Research Methodology and Applied Biostatistics. Jaypee Publishers, New Delhi.

**Articulated Attainment**

COs/POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	2	1	2	-	-		-	-	-	-	-	-	2	2	-	-
CO-2	-	2	1	-	-	2	-	-	-	-	-	-	-	1	-	-
CO-3	1	1	2	-	-	1	-	-	-	-	-	2	2	-	-	2
CO-4	1	1	1	1	-	1	-	-	-	-	2	1	-	-	-	-
CO-5	-	-	-	-	2	-	2	3	2	2	-	2	-	-	2	-
CO-6	-	-	-	-	-	-	-	2	1	-	2	1	-	-	2	-

Average	1.3	1.25	1.5	1	2	1.3	2	2.5	1.5	2	2	1.5	2	1.5	2	2
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**Elective courses  
(Students have to select any one)**

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHE-305	Credit	3(2+1)
Year/Sem	2nd/III	L-T-P	2-0-1
Course Name	<b>Advances in Breeding of Ornamental Crops</b>		

**Course Objectives:**

- 1.To impart comprehensive knowledge about the Principles-origin, distribution, genetic resources of ornamental crops.
2. To study about inheritance of flower colour, doubleness, flower size, fragrance, post harvest life.
- 3.To develop the required skills in conventional and advanced breeding methods.
- 4.To acquaint with the constraints and achievements in commercial flowers - rose, jasmine etc.

**UNIT I (Total Topics - 5 and Hrs -5)**

Principles-Evolution of varieties, origin, distribution, genetic resources, genetic divergence- Patents.

**UNIT II (Total Topics - 9 and Hrs -9)**

Genetic inheritance of flower colour, doubleness, flower size, fragrance, post harvest life. Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants-- introduction, selection, domestication, polyploid and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops.

**UNIT III (Total Topics - 8 and Hrs -8)**

Breeding constraints and achievements made in commercial flowers - rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, liliams.

**UNIT- IV (Total Topics - 8 and Hrs -8)**

Breeding constraints and achievements made in ornamental plants – petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliage– Introduction and selection of plants for waterscaping and xeriscaping.

**Practical (Experiments- 7 and Hrs -14)**

- Description of botanical features– Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies.
- Seed production-Induction of mutants through physical and chemical mutagens, induction of polyploidy.
- Screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants.

**Course Outcomes (COs):**

CO1: Identify ornamental crops.

CO2: Outline and summarize inheritance of flower colour, doubleness, flower size, fragrance, post harvest life.

CO3: Skilled in conventional and advanced breeding methods.

CO4: Apply the knowledge for the development of ornamental crops.

CO5: Capable of working on breeding programmes in flower crops.

CO6: Evaluate hybrid seed production in commercial flower crops.

**Suggested readings:**

- Agarwal, P.K. 1994. Principles of Seed Technology. ICAR Publication, New Delhi
- Agarwal, R.L. 1996. Seed Technology. Oxford & IBH Publishers, New Delhi.
- Bhattacharjee, S.K. and De, L.C. 2003. Advanced Commercial Floriculture. Aavishkar Publishers, Jaipur.
- Bose, T.K., Yadav, L.P., Patil, P., Das, P. and Sarthy, V.A. P. 2003. Commercial Flowers. Naya Udyog.
- Callaway, D.J. and Callaway, M.B. 2000. Breeding Ornamental Plants. Timber Press
- Harding, J., Singh, F. and Mol, J.N. 1991. Genetics and Breeding of Ornamental Species. Springer Publishers
- Huylenbroeck, J. V. 2018. Ornamental Crops. Springer International Publishing.
- Pal, B.P. 1966. The Rose in India. Indian Council of Agriculture Research, New Delhi.
- Roy, D. 2019. Breeding of Ornamental Crops. Alpha Science International Ltd.
- Singh, B.D. 1983. Breeding Principles and Methods. Kalyani Publishers, New Delhi.
- Vainstein. 2002. Breeding for Ornamental: Classical and Molecular Approaches. Springer Publishers.

### Articulated Attainment

COs/ POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
CO-1	1	2	1	-	1	1	-	-	-	-	1	-	1	1	1	-
CO-2	1	2	2	-	1	1	1	1	1	1	1	1	1	2	1	-
CO-3	1	1	1	1	1	1	1	1	-	-	1	1	2	1	1	1
CO-4	1	3	1	-	-	1	2	1	1	2	1	2	1	1	1	-
CO-5	3	2	3	1	1	1	1	1	1	-	-	1	2	2	-	1
CO-6	1	1	1	2	1	2	1	1	-	2	1	2	1	1	1	1
Average	1.3	1.6	1.5	1.3	1.0	1.2	1.2	1.0	1.0	1.6	1.0	1.4	1.3	1.3	1.0	1.0

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHE-306	Credit	3(2+1)
Year/Sem	2nd/III	L-T-P	2-0-1
Course Name	<b>Biodiversity and conservation of fruit crops</b>		

**Course Objectives:**

1. To understand the status and magnitude of biodiversity and strategies in germplasm conservation of fruit crops.
2. To update knowledge on centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.
3. To generate know-how on Intellectual property rights, regulatory horticulture, GIS and documentation of local biodiversity,
4. To acquaint with the Geographical indication.

**UNIT I (Total Topics - 3 and Hrs -3)**

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

**UNIT II (Total Topics - 5 and Hrs -5)**

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

**UNIT III (Total Topics - 6 and Hrs -6)**

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 (Total Topics - 7 and Hrs -7)**

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

**UNIT- V (Total Topics - 9 and Hrs -9)**

Intellectual property rights with focus on Geographical indication with reference to available germplasm of horticultural crops of the region.

Crops:

Fruits and plantation crops- Mango, Citrus, Guava, Banana, Papaya, Grapes, Aonla, Apple, Pear, Peach, Plum, Litchi, Nuts, Coffee, Tea, Rubber, Cashew, Coconut.

Vegetable crops- Potato, Tomato, Brinjal, Radish, Carrot, Cauliflower, Cabbage, Peas, French bean, Onion, Cucurbits and okra

Ornamental Plants- Rose, Marigold, Jasmine, Chrysanthemum, Bougainvillea, Carnation, Dahlia, Gerbera, gladiolus and orchids.

**Practical (Experiments- 5 and Hrs -10)**

- 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.

**Course Outcomes (COs):**

CO1: Memorize the basic concept of biodiversity.

CO2: Understand the strategies in conservation and utilization of fruit crop biodiversity.

CO3: Relate local biodiversity and geographical indication.

CO4: Relate regulatory horticulture.

CO5: Demonstrate different techniques in ex -situ conservation.

CO6: Apply strategies in germplasm conservation of fruit crops.

**Suggested readings:**

- Dhillon, B.S., Tyagi, R.K., Saxena, S. and Randhawa, G.J. 2005. Plant Genetic Resources: Horticulture Crops. Narosa Publishing House.
- Frankel, O.H. and Hawkes, J.G. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press. U.K.
- Peter, K.V. 2008. Biodiversity of Horticultural Crops (Vol. 2). Daya Publ. House.
- Peter, K.V. 2013. Biodiversity in Horticultural Crops (Vol. 4). Daya Publ. House.
- Peter, K.V. 2017. Biodiversity in Horticultural Crops (Vol. 5). Daya Publ. House.
- Peter, K.V. and Abraham, Z. 2007. Biodiversity in Horticultural Crops (Vol. I). Daya Publ. House.
- Singh, A., Trevedi, P.C. and Singh, B.P. 2016. Plant Genetic Resources: An overview. Aavishkar Publisher.
- Singh, D. and Manivannan, S. 2009. Genetic Resources of Horticultural Crops. International Book Distributing Co.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
CO-1	1	-	-	-	2	2	1	-	3	1	2	1	1	-	-	1
CO-2	3	2	1	1	-	1	2	2	3	2	1	2	2	2	1	2
CO-3	3	2	1	1	1	1	2	2	2	-	1	2	1	2	1	1
CO-4	2	2	1	-	2	1	2	2	1	1	1	2	2	2	1	-
CO-5	1	1	2	2	1	1	2	1	1	2	1	-	1	-	1	1
CO-6	2	2	1	2	1	1	2	2	1	2	1	2	2	1	1	1
Average	2.0	1.8	1.2	1.5	1.4	1.2	1.8	1.5	1.8	1.6	1.2	1.8	1.5	1.75	1.0	1.2

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHE-307	Credit	3(2+1)
Year/Sem	2nd/III	L-T-P	2-0-1
Course Name	<b>Biotic and Abiotic Stress Management in Horticultural Crops</b>		

**Course Objectives:**

1. To update knowledge on recent trends in management of abiotic stresses in horticultural crops.
2. To acquire knowledge about Stress – definition, classification, Pollution - increased level of CO<sub>2</sub>, industrial wastes, impact of stress in horticultural crop production.
3. To study about stress indices, physiological and biochemical factors associated with stress in horticultural crops.
4. To be aware about crop modeling for stress situations, cropping system, assessing the stress through remote sensing, use of anti transpirants and PGRs in stress management, HSP inducers in stress management.

**UNIT I (Total Topics - 4 and Hrs -4)**

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.).

**UNIT II (Total Topics - 5 and Hrs -5)**

Pollution - increased level of CO<sub>2</sub>, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations.

**UNIT III (Total Topics - 6 and Hrs -6)**

Crop modeling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stress and their impact on crop growth and productivity.

**UNIT- IV (Total Topics - 8 and Hrs -8)**

Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers.

**UNIT- V (Total Topics - 7 and Hrs -7)**

Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

**Practical (Experiments- 5 and Hrs -10)**

- Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP)
- Analysis of plant stress factors, RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations
- Influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management
- Visit to orchards and water shed locations.

**Course Outcomes (COs):**

CO1: Describe abiotic stresses in horticultural crops.

CO2: Classify and categorize Stress and impact of stress in horticultural crop production.

CO3: Study of stress indices, physiological and biochemical factors associated with stress in horticultural crops.

CO4: Correlate Crop modeling in stress management.

CO5: Analyze specific plant stress factors.

CO6: Evaluating stress on growth and development of plants.

**Suggested readings:**

- Dwivedi, P. and Dwivedi, R.S. 2005. Physiology of Abiotic stress in Plants. Agrobios.
- Gurumurthy, S and Jinus, S. 2020. Management of Abiotic Stress in Crop Plants. IP Innovative Publication Pvt. Ltd.
- Kumar, A., Rai, A. C., Rai, A., Rai, K. K. and Rai, V. P. 2021. Stress Tolerance in Horticultural Crops: Challenges and Mitigation Strategies. Woodhead Publishing.
- Maloo, S.R. 2003. Abiotic Stress and Crop Productivity. Agrotech Publ. Academy.
- Mussell, H. and Staples, R. 1979. Stress Physiology in Crop Plants. Wiley Inter. Science.
- Rao, N.K.S., Shivashankara, K.S. and Laxman, R. H. 2016. Abiotic Stress Physiology of Horticultural Crops. Springer India.
- Sinha, B. K and Reena. 2018. Abiotic and Biotic Stress Management in Plants: Biotic Stress, (Vol.02). New India Publishing Agency.
- Sinha, B. K and Reena. 2018. Abiotic and Biotic Stress Management in Plants: Abiotic Stress (Vol.01). New India Publishing Agency.

**Articulated Attainment**

COs POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	1	1	1	1	-	1	1	2	1	-	1	2	-	1	1	-
CO-2	3	1	1	2	1	2	-	1	1	1	-	1	-	2	2	1
CO-3	1	2	2	1	-	1	-	2	2	3	-	2	2	1	1	-
CO-4	-	1	1	1	-	1	1	1	1	-	1	1	-	1	1	-
CO-5	3	1	1	2	3	2	-	1	1	1	1	1	2	2	2	1
CO-6	1	1	1	1	1	1	1	2	2	3	1	2	1	1	-	1
Average	1.8	1.2	1.2	1.3	1.6	1.3	1.0	1.5	1.3	2.0	1.0	1.5	1.6	1.3	1.2	1.0

Programme Name	M.Sc. (Ag.) Horticulture	Programme Code	MSC-HORT-1099
Course Code	MSHE-308	Credit	3(2+1)
Year/Sem	2nd/III	L-T-P	2-0-1
Course Name	<b>Canopy Management in Fruit Crops</b>		

**Course Objectives:**

1. To study about factors affecting canopy development.
2. To acquire knowledge about types, structure, light interception and distribution in different types of tree canopies.
3. To study about canopy classification and management.
4. To develop the skills of canopy management through plant growth inhibitors, training and pruning

**UNIT I (Total Topics - 3 and Hrs -3)**

Canopy management - importance and advantages; factors affecting canopy development.

**UNIT II (Total Topics - 6 and Hrs -6)**

Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies.

**UNIT III (Total Topics - 8 and Hrs -8)**

Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion.

**UNIT- IV (Total Topics - 6 and Hrs -6)**

Canopy management through plant growth inhibitors, training and pruning and management practices.

**UNIT- V (Total Topics - 7 and Hrs -7)**

Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passion fruits, mango, sapota, guava, citrus and ber.

**Practical (Experiments- 5 and Hrs -10)**

- Study of different types of canopies
- Training of plants for different canopy types
- Canopy development through pruning,
- Use of plant growth inhibitors, geometry of planting
- Study on effect of different canopy types on production and quality of fruits.

**Course Outcomes (COs):**

CO1: Describe canopy management in fruit crops.

CO2: Classify and categorize canopy types and light utilization.

CO3: Study of canopy management through plant growth inhibitors, training and pruning.

CO4: Correlate development and management in fruit crops.

CO5: Analyze flowering and fruiting behaviours in fruit crops.

CO6: Evaluate different canopy management practices.

**Suggested readings:**

- Chaddha, K.L. and Shikhamany, S.D. 1999. The Grape, Improvement, Production and Post Harvest Management. Malhotra Publication House.
- Pradeep kumar T., Suma B., Jyothibhaskar and Satheesan, K.N. 2008. Management of Horticultural Crops. New India Publishing Agency.

- Singh, G. 2010. Practical Manual on Canopy Management in Fruit Crops. Department of Agriculture & Co. Ministry of Agriculture, Government of India.
- Srivastava, K.K. 2007. Canopy Management of Fruit Crops. International Book Distributing Co.

**Articulated Attainment**

COs/ POs/	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO-2	PSO-3	PSO-4
CO-1	1	2	1	-	-	-	2	1	1	-	-	2	1	-	-	-
CO-2	1	-	1	-	1	1	2	1	1	-	1	2	1	1	1	1
CO-3	1	1	-	-	1	1	2	2	-	-	1	2	1	-	1	-
CO-4	1	2	-	-	1	2	1	1	1	1	1	1	1	-	1	-
CO-5	1	1	1	1	1	1	1	1	2	1	1	-	1	1	1	1
CO-6	1	-	1	1	1	1	2	1	1	2	1	1	1	1	1	1
Average	1.0	1.5	1.0	1.0	1.0	1.2	1.6	1.2	1.2	1.3	1.0	1.6	1.0	1.0	1.0	1.0