PG Degree Programme Syllabus as per ICAR

M. Sc. (Ag.) Horticulture

Department of Horticulture

Session: 2023-2024 onwards

- **Programme Structure**
- **Programme Outcomes (POs)**
- **Course Outcomes (COs)**
- **Detailed Syllabus (Course Contents)**

1. Framework of the M.Sc. (Ag.) Horticulture course on the basis of credits requirements as per ICAR

The following nomenclature and Minimum Credit Hrs. need to be followed while providing the syllabus for Master Programme in Horticulture:

Courses	Master's Programme (Credits hrs.)
Major courses	20
Minor courses	08
Supporting courses	06
Common courses	05
Seminar	01
Thesis	30
Total	70

- **Major courses:** From the Discipline in which a student takes admission.
- **Minor courses:** From the subjects closely related to a student's major subject.
- **Supporting courses:** The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.
- **Common Courses:** The following below mention common courses (one credit each) will be offered to all students undergoing Master's degree programme:

Common compulsory courses		
Course No.	Course Title	Cr. hr
PGS -501	Technical Writing and Communications Skills	0+1
PGS -502	Library and Information Services	0+1
PGS -503	Intellectual Property and its Management in Agriculture	1+0
PGS -504	Basic Concepts in Laboratory Techniques	0+1
PGS -505	Agricultural Research, Research Ethics and Rural Programmes Development	1+0

2. Evaluation of course work and comprehensive examination

For M.Sc., multiple levels of evaluation (First Test, Midterm and Final semester) are desirable. However, it has been felt that the comprehensive examination is redundant for M.Sc. students. The evaluation pattern shall be as follows:

Evaluation Pattern (MM-100)		
Internal		**External**
Sessional Test	**Practical**	**Theory**
30	**20**	**50**

Prof. Rajendra Singh (Rajju Bhaiya) University, Naini, Prayagraj

DEPARTMENT OF HORTICULTURE
M.Sc. (Ag.) HORTICULTURE
PROGRAMME STRUCTURE

MAJOR COURSE

Course Code		Course Title	Credits	T/P	EVALUATION (MM=100)		
					Internal		External
					CIE	Practical	ETE
HORT-511	CORE	*PROPAGATION AND NURSERY MANAEMENT OF FRUIT CROPS	2(1+1)	T/P	30	20	50
HORT-512	CORE	*PRODUCTION OF COOL SEASON VEGETABLE CROPS	3(2+1)	T/P	30	20	50
HORT-513	CORE	*TROPICAL AND MINOR FRUIT PRODUCTION	3(2+1)	T/P	30	20	50
HORT-521	CORE	*SUB-TROPICAL AND TEMPERATE FRUIT PRODUCTION	3(2+1)	T/P	30	20	50
HORT-522	CORE	*PRODUCTION OF WARM SEASON VEGETABLE CROPS	3(2+1)	T/P	30	20	50
HORT-515	CORE	CORMMERCIAL PRODUCTION OF CUT AND LOOSE FLOWERS	3(2+1)	T/P	30	20	50
HORT-516	CORE	POST HARVEST MANAGEMENT AND PRESERVATION OF FRIUT AND VEGETABLES	3(2+1)	T/P	30	20	50
HORT-517	CORE	PRODUCTION OF MEDICINAL AND AROMATIC CROPS	3(2+1)	T/P	30	20	50
Total			20				

MINOR COURSE

Course Code		Course Title	Credits	T/P	EVALUATION (MM=100)		
					Internal		External
					CIE	Practical	ETE
HORT-514	CORE	ORNAMENTAL GARDENING AND LAND SCAPING	3(2+1)	T/P	30	20	50
HORT-523	CORE	PROTECTED CULTIVATION OF HORTICULTURAL CROPS	2(1+1)	T/P	30	20	50
HORT-518	CORE	BREEDING OF HORTICULTRUAL CROPS	3(2+1)	T/P	30	20	50
Total			8				

SUPPORTING COURSE

Course Code		Course Title	Credits	T/P	EVALUATION (MM=100)		
					Internal		External
					CIE	Practical	ETE
COMP-502	CORE	INFORMATION TECHNOLOGY IN AGRICULTURE	3(1+1)	T/P	30	20	50
MCA 501		Computers Fundamentals and Program.	3(2+1)				
STAT-511	CORE	EXPERIMENTAL DESIGNS	3(2+1)	T/P	30	20	50
STAT-512		STATISTICAL METHODS FOR APPLIED SCIENCE	3(3+1)				
Select Course from each one		Total	6				

COMMON COURSE

Course Code	Course Title	Credits	T/P	EVALUATION (MM=100)		
				Internal		External
				CIE	Practical	ETE
PGS -501	TECHNICAL WRITING AND OMMUNICATION SKILLS	1(0+1)	P	40*10	50	00
PGS -502	LIBRARY AND INFORMATION SERVICES	1(0+1)	P	40*10	50	00
PGS -503	INTELLECTUAL PORPERTY AND ITS MANAGEMENTIN AGRICULTURE	1(1+0)	T	50	00	50
PGS -504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	1(0+1)	P	40*10	50	00
PGS -505	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1(1+0)	T	50	00	50
Total		5				

THESIS

COURSE CODE	COURSE TITLE	Credits	T/P	Internal	External
HORT-591	SEMINAR	1(0+1)	P	100	-
HORT-599	THESIS	30(0+30)	P	-	100
Total		31			

Prof. Rajendra Singh (Rajju Bhaiya) University, Naini, Prayagraj

DEPARTMENT OF HORTICULTURE

PROGRAMME STRUCTURE

M.Sc. (Ag.) Horticulture

Semester wise allocation of courses with credit load

Semester

Course Code	Course Title		Credits	T/P	EVALUATION (MM=100)		
					Internal		External
					CIE	Practical	ETE
HORT-511	PROPAGATION AND NURSERY MANAEMENT OF FRUIT CROPS	Major	2(1+1)	T	30	20	50
HORT-512	PRODUCTION OF COOL SEASON VEGETABLE CROPS	Major	3(2+1)	T	30	20	50
HORT-513	TROPICAL AND MINOR FRUIT PRODUCTION	Major	3(2+1	T	30	20	50
HORT-514	ORNAMENTAL GARDENING AND LAND SCAPING	Minor	3(2+1	T	30	20	50
PGS -501	TECHNICAL WRITING AND COMMUNICATION SKILLS	Common	1(0+1)	P	40+10*	50	00
PGS -502	LIBRARY AND INFORMATION SERVICES	Common	1(0+1)	P	40+10*	50	00
Total			**13**				

Semester-II

Course Code		Course Title		Credits	T/P	EVALUATION (MM=100)		
						Internal		External
						CIE	Practical	ETE
HORT-521		SUB-TROPICAL AND TEMPERATE FRUIT PRODUCTION	Major	3(2+1)	T	30	20	50
HORT-522		PRODUCTION OF WARM SEASON VEGETABLE CROPS	Major	3(2+1)	T	30	20	50
HORT-523		PROTECTED CULTIVATION OF HORTICULTURAL CROPS	Minor	2(1+1)	T	30	20	50
STAT-511	Elective (Select anyone)	EXPERIMENTAL DESIGNS	Supporting	3(2+1)	T	30	20	50
STAT-512		STATISTICAL METHODS FOR APPLIED SCIENCE						
PGS -503		INTELLECTUAL PORPERTY AND ITS MANAGEMENT IN AGRICULTURE	Common	1(1+0)	T	40+10*	00	50
PGS -504		BASIC CONCEPTS IN LABORATORY TECHNIQUES	Common	1(0+1)	P	40+10*	50	00
Total				**13**				

Semester-III

Course Code	Course Title		Credits	T/P	EVALUATION (MM=100)		
					Internal		External
					CIE	Practical	ETE
HORT-515	CORMMERCIAL PRODUCTION OF CUT AND LOOSE FLOWERS	Major	3	T	30	20	50
HORT-516	POST HARVEST MANAGEMENT AND PRESERVATION OF FRIUT AND VEGETABLES	Major	3	T	30	20	50
HORT-518	BREEDING OF HORTICULTRUAL CROPS	Minor	3	T	30	20	50
COMP-501	COMPUTERS FUNDAMENTALS AND PROGRAMING	Supporting	3	T	30	20	50
PGS-505	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	Common	1(1+0)	T	40+10*	00	50
Total			**13**				

Semester-IV

COURSE CODE	COURSE TITLE	TYPE	Credits	T/P	Internal	External
HORT-591	SEMINAR	Compulsory	1(0+1)	P	100	-
HORT-599	THESIS	Compulsory	30(0+30)	P	-	100
Total			**31**			

Thesis Guidelines:

1st Semester- a Supervisor/Advisor and a Topic/title allotment for his/her thesis.

2nd & 3rd Sem.-Synopsis presentation, Research field allotment, experimentation data collection etc.

4th Sem.- Seminar, Data Analysis, Thesis writing, Pre-submission, and Thesis Evaluation.

Criteria for thesis Evaluation

1. Synopsis: There will be a research advisory committee also called (SAC) student advisory committee, at institutions level.
2. Synopsis presentation will be conducted in presence of sixty percent of member will form the quorum SAC members.
3. The research advisor of Student shall be convenor of this committee. This committee will have following responsibilities:
   i) To review the research title and finalize the topic of research
   ii) To guide the student to build up the study design and research methodology
   iii) To periodically review and guide in the progress of research work of the students
4. There will be pre- submission examiner by the student before SAC at institution level.
5. After incorporating the suggestion final thesis will be submitted to the university for evaluation.
6. Pannal of external & internal examiner will be appointed by the university.
7. The place of final presentation viva voice examination will be decided by the university.

Note:

` Total credits to be earned by a student for completion of the PG program:40+30 (Thesis) =70

Prof. Rajendra Singh (Rajju Bhaiya) University, Naini, Prayagraj

PG DEGREE PROGRAMME SYLLABUS AS PER ICAR
M.SC. (AG) HORTICULTURE

SEMESTER -I

HORT-511: PROPAGATION AND NURSERY MANAGEMEN OF FRUIT CROPS

2(1+1)

WHY THIS COURSE?

Availability of sufficient and healthy planting material is pivotal for expanding fruit culture. This necessitates requisite skill and efficient multiplication protocols for raising plants and their in-house management prior to distribution or field transfer, hence the course is developed.

AIM OF THIS COURSE

To understand the principles and methods of propagation and nursery management in fruit crops. The course is organised as follows:-

S. No.	Blocks	Units
1	Introduction	General Concepts and Phenomena
2	Propagation	1. Conventional Asexual Propagation
		2.Micropropagation
3	Nursery	Management Practices and Regulation

LEARNING OUTCOMES

The student would be expected to equip to acquire skills and knowledge on principles and practices of macro and micropropagation and the handling of propagated material in nursery.

THEORY

Block 1: Introduction

Unit 1: General Concepts and Phenomena: Introduction, understanding cellular basis for propagation, sexual and asexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of fruit crops, dormancy, hormonal regulation of seed germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing.

Block 2: Propagation

Unit I: Conventional Asexual Propagation: Cutting– methods, rooting of soft and hardwood cuttings under mist and hotbeds. Use of PGR in propagation, Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods. Budding and grafting – principles and methods, establishment and management of bud wood bank.

Stock, scion and inter stock relationship - graft incompatibility, physiology of rootstock and top working.

Unit II: Micropropagation: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - in vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules.

Block 3: Nursery

Unit I: Management Practices and Regulation: Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, nursery accreditation, import and export of seeds and planting material and quarantine.

PRACTICAL

1. Hands on practices on rooting of dormant and summer cuttings
2. Anatomical studies in rooting of cutting and graft union
3. Hands on practices on various methods of budding and grafting
4. Propagation by layering and stooling
5. Micropropagation- explant preparation, media preparation, culturing – meristem tip culture, axillary bud culture, micro-grafting, hardening
6. Visit to commercial tissue culture laboratories and accredited nurseries

TEACHING METHODS / ACTIVITIES

- Class room Lectures
- Laboratory / Field Practical's
- Student Seminars / Presentations
- Field Tours / Demonstrations
- Assignments

SUGGESTED READINGS

- Bose, T. K., Mitra, S. K. and Sadhu, M.K., 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkata.
- Davies, F.T, Geneve, R.L. and Wilson, S.B. 2018. Hartmann and Kester's Plant Propagation Principles and Practices. Pearson, USA/Prentice Hall of India. New Delhi.
- Gill, S. S., Bal, J. S. and Sandhu, A. S. 2016. Raising Fruit Nursery. Kalyani Publishers, New Delhi.
- Jain, S. and Ishil, K. 2003. Micropropagation of Woody Trees and Fruits. Springer.

- Jain, S. and Hoggmann, H. 2007. Protocols for Micropropagation of Woody Trees and Fruits. Springer.
- Joshi, P. 2015. Nursery Management of Fruit Crops in India. NIPA, New Delhi.
- Love et al.2017. Tropical Fruit Tree Propagation Guide. UH-CTAHR F_N_49. College of Tropical Agriculture and Human Resources University of Hawaii at Manwa, USA.
- Peter, K.V., eds., 2008. Basics of Horticulture. New India Publishing Agency, New Delhi.
- Rajan, S. and Baby, L.M., 2007. Propagation of Horticultural Crops. NIPA, New Delhi.
- Sharma, R.R., 2014. Propagation of Horticultural Crops. Kalyani Publishers, New Delhi.
- Sharma, R.R. and Srivastav, M., 2004. Propagation and Nursery Management. Intl. Book Publishing Co., Lucknow.
- Singh, S. P. 1989. Mist Propagation. Metropolitan Book Co.
- Singh, R. S. 2014. Propagation of Horticultural Plants: Arid and Semi-Arid Regions. NIPA, New Delhi.
- Tyagi, S. 2019. Hi-Tech Horticulture. Vol I: Crop Improvement, Nursery and Rootstock Management. NIPA, New Delhi

HORT-512: PRODUCTION OF COOL SEASON VEGETABLE CROPS 3(2+1)

WHY THIS COURSE?

Cool season vegetables are a major source of dietary fibres, minerals and vitamins. Some of these vegetables also contribute protein, fat and carbohydrate. Most of the leafy and root vegetables are rich in minerals, especially in micro-elements such as copper, manganese and zinc. Vegetables differ in their temperature requirement for proper growth and development. Most of the winter vegetable crops are cultivated in cool season when the monthly mean temperature does not exceed 21°C. Even in temperate climate, these vegetables are cultivated in spring summer in hilly tracks where the daytime temperature in summer is less than 21°C. The students of vegetable science need to have an understanding of production technology of important cool season vegetable crops and their management.

AIM OF THIS COURSE:

To impart knowledge and skills on advancement in production technology of cool season vegetable crops. The course is constructed given as under:

No.	Block	Unit
1.	1. Production of cool season vegetable crops-	1. Bulb and tuber crops
		2. Cole crops
		4. Peas and beans
		5. Leafy vegetables

LEARNING OUTCOMES

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of cool season vegetable crops in India
- Acquire knowledge about the production technology and post-harvest handling of cool season vegetable crops
- Calculate the economics of vegetable production in India

THEORY

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/hybrids, seed rate and seed treatment, raising of nursery, sowing/planting time and methods,hrydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of crops.

Unit I: Bulb and tuber crops- Onion, garlic and potato

Unit II: Cole crops- Cabbage, cauliflower, kohlrabi, broccoli, Brussels sprouts and kale

Unit III: Root crops- Carrot, radish, turnip and beetroot

Unit IV: Peas and beans- Garden peas and broad bean

Unit V: Leafy vegetables- beet leaf, fenugreek, coriander and lettuce

PRACTICAL

1. Scientific raising of nursery and seed treatment
2. Sowing and transplanting
3. Description of commercial varieties and hybrids
4. Demonstration on methods of irrigation, fertilizers and micronutrients application
5. Mulching practices, weed management
6. Use of plant growth substances in cool season vegetable crops
7. Study of nutritional and physiological disorders
8. Studies on hydroponics, aeroponics and other soilless culture
9. Identification of important pest and diseases and their control
10. Preparation of cropping scheme for commercial farms
11. Visit to commercial farm, greenhouse/polyhouses
12. Visit to vegetable market
13. Analysis of benefit to cost ratio

TEACHING METHODS/ACTIVITIES

- Classroom lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

SUGGESTED READINGS

- Bose, T.K., Kabir, J., Maity, T.K., Parthasarathy, V.A. and Som, M.G., 2003. Vegetable crops. Vols. I-III. Naya udyog.
- Bose, T.K., Som, M.G. and Kabir, J. (Eds.). 1993. Vegetable crops. Naya prokash.
- Chadha, K.L. and Kalloo, G. (Eds.), 1993-94. Advances in horticulture Vols. V-X. Malhotra publ. house.
- Chadha, K.L. (Ed.), 2002. Hand book of horticulture. ICAR.
- Chauhan, D.V.S. (Ed.), 1986. Vegetable production in India.
- Ram prasad and sons. Fageria, M.S., Choudhary, B.R. and Dhaka, R.S., 2000, Vegetable crops: production technology. Vol. II. Kalyani publishers.
- Gopala krishanan, T.R., 2007, Vegetable crops. New India publ. agency.

- Hazra, P. and Banerjee M.K. and Chattopadhyay, A., 2012, Varieties of vegetable crops in India, (Second edition), Kalyani publishers, Ludhiana , 199 p
- Hazra, P., 2016, Vegetable science. 2ndedn, Kalyani publishers, Ludhiana.
- Hazra, P., 2019, Vegetable production and technology. New India publishing agency, New Delhi.
- Hazra, P., Chattopadhyay, A., Karmakar K. and Dutta, S., 2011, Modern technology for vegetable production, New India publishing agency, New Delhi,
- Rana, M,K., 2008, Olericulture in India. Kalyani publ.
- Rana, M.K., 2008, Scientific cultivation of vegetables. Kalyani publ.
- Rana, M.K., 2014, Technology for vegetable production. Kalyani publishers, New Delhi.
- Rubatzky, V.E. and Yamaguchi, M. (Eds.), 1997, World vegetables: principles, production and nutritive values. Chapman and Hall.
- Saini, G.S., 2001, A text book of oleri and flori culture. Aman publishing house.
- Salunkhe, D.K. and Kadam, S.S. (Ed.), 1998, Hand book of vegetable 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. (Ed.), 1989, Production technology of vegetable crops. Agril. comm. res. centre.
- Thamburaj, S. and Singh, N. (Eds.), 2004, Vegetables, tuber crops and spices. ICAR. Thompson, H.C. and Kelly, W.C. (Eds.), 1978, Vegetable crops. Tata McGraw-Hill.

HORT-513: TROPICAL AND MINOR FRUIT PRODUCTION 3(2+1)

WHY THIS COURSE?

Tropical fruits occupy a distinct place in global fruit production. Apart from ecological specificities, tropical fruits enjoy favour among masses being delicious and nutritious. As such, the course has been designed to provide update knowledge on various production technologies of tropical fruits on sustainable basis.

AIM OF THIS COURSE:

To impart comprehensive knowledge to the students on cultural and management practices for growing tropical fruits. The course is organised as follows:-

S.No.	Blocks	Units
1	Introduction	Importance and Background Occurrence, And Adoption
2	Agro-Techniques	Propagation, Planting and Orchard Floor Management
3	Crop Management	Flowering, Fruit-Set and Harvesting
4	Marketing and utilization	Post-Harvest Management

LEARNING OUTCOMES

The students are expected to equip themselves with know-how on agro-techniques for establishment and management of an orchard leading to optimum and quality fruit production of tropical fruits.

THEORY

Block 1: Introduction

Unit I: Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, Eco physiological requirements.

Block 2: Agro - Techniques

Unit I: Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of biofertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Unit I: Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders - causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

MAJOR CROPS

Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla and Ber

MINOR CROPS

Bael, fig, passionfruit, jamun, phalsa, karonda, wood apple, lasoda, loquat, tamarind, dragon fruit, monkey jack, khirni, cape gooseberry, persimmon, pistachio, hazel nut and Other minor fruits of regional importance.

PRACTICALS

1. Distinguished features of tropical fruit species, cultivars and rootstocks
2. Demonstration of planting systems, training and pruning
3. Hands on practices on pollination and crop regulation
4. Leaf sampling and nutrient analysis
5. Physiological disorders-malady diagnosis
6. Physico-chemical analysis of fruit quality attributes
7. Field/Exposure visits to tropical orchards
8. Project preparation for establishing commercial orchards

TEACHING METHODS / ACTIVITIES

- Class room Lectures
- Laboratory / Field Practicals
- Student Seminars / Presentations
- Field Tours / Demonstrations
- Assignments

SUGGESTED READINGS

- Bartholomew, D.P., Paull, R.E. and Rohrbach, K.G. 2002. The Pineapple: Botany, Production, and Uses. CAB International.
- Bose, T, K., Mitra, S.K. and Sanyal, D., 2002. Fruits of India – Tropical and Sub-Tropical.3rd Edn. Naya Udyog, Kolkata.
- Dhillon, W.S., 2013. Fruit Production in India. Narendra Publ. House, New Delhi.
- Iyer, C. P. A. and Kurian, R. M. 2006. High Density Planting in Tropical Fruits: Principles and Practices. IBDC Publishers, New Delhi.
- Litz, R.E. 2009. The Mango : Botany, Production and Uses. CAB International.
- Madhawa Rao, V. N. 2013. Banana. ICAR, New Delhi.
- Midmore, D. 2015. Principles of Tropical Horticulture. CAB International.

- Mitra, S. K. and Sanyal, D. 2013. Guava, ICAR, New Delhi.
- Morton, J F. 2013. Fruits of Warm Climates. Echo Point Book Media, USA.
- Nakasome, H. Y and Paull, R. E. 1998. Tropical Fruits. CAB International.
- Paull, R.E. and Duarte, O., 2011. Tropical Fruits (Vol. 1). CAB International.
- Rani, S., Sharma, A. and Wali, V. K. 2018. Guava (*Psidium guajava* L.). Astral, New Delhi.
- Robinson, J.C. and Saúco, V.G. 2010. Bananas and Plantains. CAB International.
- Sandhu, S. and Gill, B.S. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi
- Schaffer, B., Wolstenholme, B. N. and Whiley, A. W. 2013. The Avocado: Botany, Production and Uses. CAB International
- Sharma, K. K. and Singh, N. P. 2011. Soil and Orchard Management. Daya Publishing House, New Delhi.
- Valavi, S.G., Peter, K.V. and Thottappilly, G., 2011. The Jackfruit. Stadium Press, USA.

HORT 514: ORNAMENTAL GARDENING AND LANDSCAPING 3(2+1)

WHY THIS COURSE?

Ornamental gardening and landscaping is an important course which gives a thorough understanding of different types of gardens and their components. The students need to imbibe the principles of landscaping and should develop skills for planning under different situations.

AIM OF THIS COURSE:

Familiarization with principles and practices of landscaping. The course is organized as follows

S. No.	Blocks	Units
1	Gardens and components	1. Styles and types of gardens
		2. Garden components
		3. Specialized gardens
2	Landscape planning	1. Principles and elements of landscaping
		2. Landscaping for different situations

LEARNING OUTCOMES

After successful completion of this course, the students are expected to be

- The students will be apprised of different types of gardens and have a thorough understanding of principles of landscape gardening
- Develop skills for landscaping under different situations and layout of garden components.

THEORY

Block 1: Gardens and components

UNIT I: Styles and types of gardens: Historical background of gardening, Importance and scope of ornamental gardening, styles and types of gardens, formal and informal style gardens. English, Mughal, Japanese, Persian, Spanish, Italian, French, Hindu and Buddhist gardens.

UNIT II: Garden components: Garden components (living and non-living): arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, colour wheels , clock garden, bamboo groves, bonsai; Non -living components like- path, garden gate, fencing, paving and garden features like fountains, garden seating, swings, lanterns, basins, bird baths, sculptures, waterfalls, bridge, steps, ramps, Lawn -genera and species, establishment and maintenance.

UNIT III: Specialized gardens: Specialised gardens such as vertical garden, roof garden, terrace garden, water garden, sunken garden, rock garden, shade garden, temple garden, sacred gardens (with emphasis on native plants), Zen Garden.

Block 2: Landscape planning

UNIT I: Principles and elements of landscaping: Basic drawing skills, use of drawing instruments garden symbols, steps in preparation of garden design, programmes phase, design, phase, etc. Elements and principles of landscape design. Organization of spaces, visual aspects of plan arrangement- view, vista and axis. Principles of circulation, site analysis and landscape, water requirement, use of recycled water

UNIT II: Landscaping for different situations: Urban landscaping, Landscaping for specific situations such as residential, farm houses, institutions, corporate sector, industries, hospitals, roadsides, traffic islands, Children parks, public parks, xeriscaping, airports, railway station and tracks, river banks and dam sites and IT/ SEZ parks. Bio-aesthetic planning, ecotourism, theme parks, indoor gardening, therapeutic gardening,

PRACTICALS

1. Graphic language and symbols in landscaping, study of drawing instruments viz., 'T' square, setsquare, drawing board, etc.
2. Identification of various types of ornamental plants for different gardens and occasions
3. Preparation of land, planning, layout and planting, deviations from landscape principles
4. Case study
5. Site analysis, interpretation of map of different sites, use of GIS for selection
6. Enlargement from blue print. Landscape design layout and drafting on paper as per the scale
7. Preparation of garden models for home gardens, farm houses, industrial gardens, institutional gardens, corporate, avenue planting, practices in planning and planting of special types of gardens.
8. Bur lapping, lawn making, planting of edges, hedges, topiary, herbaceous and shrubbery borders
9. Project preparation on landscaping for different situations, creation of formal and informal gardens.
10. Visit to parks and botanical gardens.

TEACHING METHODS/ACTIVITIES

- Lectures
- Group discussions
- Flip classes
- Assignment and group seminars
- Hands on training on different models of landscaping Exposure visits

SUGGESTED READINGS

- Bose T. K., Chowdhury, B. & Sharma, S. P. 2011. Tropical Garden Plants in Colour. Hort. and Allied Publ.
- Bose, T. K., Maiti, R.G., Dhua, R.S. & Das P. 1999. Floriculture and Landscaping. Naya Prokash, Kolkata, India.
- Grewal, H. S. & Singh, P. 2014. Landscape Designing and Ornamental Plants. Kalyani Publ.
- Lauria, A. & Victor, H.R. 2001. Floriculture-Fundamentals and Practices. Agrobios Publ., Jodhpur.

- Misra, R. L. &Misra, S. 2012. Landscape Gardening. Westville Publ. House, New Delhi, India.
- Nambisan, K.M.P.1992. Design Elements of Landscape Gardening. Oxford & IBH Publ. Co., New Delhi, India.
- Randhawa, G.S. & Mukhopadhyay, A. 1986. Floriculture in India. Allied Publ.
- Sabina ,G.T. & Peter, K.V. 2008. Ornamental Plants for Gardens. New India Publ. Agency, New Delhi, India.
- Singh, A. & Dhaduk, B. K. 2015. A Colour Handbook: Landscape Gardening. New India Publ. Agency, New Delhi, India.
- Valsalakumari, P. K., Rajeevan, P. K., Sudhadevi, P. K. & Geetha C.K. 2008. Flowering Trees. New India Publ. Agency, New Delhi, India.
- Woodrow, M. G.1999. Gardening in India. Biotech Books, New Delhi, India.

PGS-501 : TECHNICAL WRITING AND COMMUNICATIONS SKILLS (0+1)

Objective

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

Practical (Technical Writing)

• Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.;

• Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);

• Writing of abstracts, summaries, précis, citations, etc.; Commonly used abbreviations in the theses and research communications;

• Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations;

• Writing of numbers and dates in scientific write-ups;

• Editing and proof-reading;

• Writing of a review article;

• Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks);

• Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription;

• Accentual pattern: Weak forms in connected speech;

• Participation in group discussion;

• Facing an interview;

• Presentation of scientific papers.

SUGGESTED READINGS

1. Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.

2. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

3. Collins' Cobuild English Dictionary. 1995.

4. Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.

5. Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.

6. James HS. 1994. Handbook for Technical Writing. NTC Business Books.

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

8. Mohan K. 2005. Speaking English Effectively. MacMillan India.

9. Richard WS. 1969. Technical Writing.

10. Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.

PGS- 502 : LIBRARY AND INFORMATION SERVICES (0+1)

Objective

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

Practical

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

SEMESTER -II

HORT-521: SUB-TROPICAL AND TEMPERATE FRUIT PRODUCTION 3(2+1)

WHY THIS COURSE?

Agro-climatic diversity in India facilitates growing a wide range of fruits extending from tropical to subtropical to temperate fruits and nuts. To highlight their ecological specificities, seasonal variations and pertinent cultural practices, a course is designed exclusively for subtropical and temperate fruits.

AIM OF THIS COURSE:

To impart comprehensive knowledge to the students on cultural and management practices for growing subtropical and temperate fruits.

The course is organised as fellows: -

S. No.	Blocks	Units
1	Introduction	Importance and Background
2	Agro Techniques	Propagation, Planting and Orchard Floor Management
3	Crop Management	Flowering, Fruit- Set and Harvesting

LEARNING OUTCOMES

After successful completion of the course, the student are expected to equip themselves with principles and practices of producing subtropical (citrus, grapes, litchi, pomegranate etc.) and temperate fruits (apple, pear, peach, plum, apricot, cherries, berries, kiwifruit etc.) and nuts (almond, walnut, pecan etc.)

THEORY

Block 1: Introduction

Unit I: Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, Eco physiological requirements.

Block 2: Agro - Techniques

Unit I: Propagation, Planting and Orchard Floor Management: Propagation, planting systems and densities, training and pruning, rejuvenation and replanting, intercropping, nutrient

management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production.

Block 3: Crop Management

Unit I: Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders- causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management.

CROPS

Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond and Pecan

PRACTICALS

1. Distinguished features of fruit species, cultivars and rootstocks
2. Demonstration of planting systems, training and pruning
3. Hands on practices on pollination and crop regulation
4. Leaf sampling and nutrient analysis
5. Physiological disorders-malady diagnosis
6. Physico-chemical analysis of fruit quality attributes
7. Field/Exposure visits to subtropical and temperate orchards
8. Project preparation for establishing commercial orchards

TEACHING METHODS / ACTIVITIES

- Class room Lectures
- Laboratory / Field Practical's
- Student Seminars / Presentations
- Field Tours / Demonstrations
- Assignments

SUGGESTED READINGS

- Chadha, K.L. and Awasthi, R.P. 2005. The Apple. Malhotra Publishing House, New Delhi.
- Chadha, T.R. 2011. A Text Book of Temperate Fruits. ICAR, New Delhi

- Childers, N. F., Morris, J. R. and Sibbett, G. S. 1995. Modern Fruit Science : Orchard and Small Fruit Culture. Horticultural Publications, USA.
- Creasy, G and Creasy L. 2018. Grapes. CAB International.
- Davies, F.S. and Albrigo, L.G., 1994. Citrus. CAB International.
- Dhillon, W.S., 2013. Fruit Production in India. Narendra Publishing House, New Delhi.
- Jackson, D., Thiele, G., Looney, N. E. and Morley-Bunker, M. 2011. Temperate and Subtropical Fruit Production. CAB International.
- Ladanyia, M., 2010. Citrus Fruit : Biology, Technology and Evaluation. Academic Press.
- Layne, D.R. and Bassi, D. 2008. The Peach: Botany, Production and Uses. CABI.
- Menzel, C. M. and Waite, G. K. 2005. Litchi and Longan: Botany, Production and Uses. CAB International.
- Pandey , R. M. and Randey, S. N. 1996. The Grape in India. ICAR, New Delhi.
- Rajput, C.B.S. and Haribabu, R.S. 2006. Citriculture, Kalyani Publishers, New Delhi.
- Sandhu, S. and Gill, B. S. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi.
- Sharma, R. M., Pandey, S. N. and Pandey, V. 2015. The Pear - Production, Post- harvest Management and Protection. IBDC Publisher, New Delhi.
- Sharma, R. R. and Krishna, H., 2018. Textbook of Temperate Fruits. CBS Publishers and Distributors Pvt. Ltd., New Delhi.
- Singh, S., Shivshankar, V. J, Srivastava, A. K. and Singh I. P. 2004. Advances in Citriculture. NIPA, New Delhi.
- Tromp, J., Webster, A. S. and Wertheim, S. J. 2005. Fundamentals of Temperate Zone Tree Fruit Production.Backhuys Publishers, Lieden, The Netherlands.\
- Webster, A. and Looney, N. Cherries : Crop Physiology, Production and Uses. CABI.
- Westwood, M. N. 2009. Temperate Zone Pomology:Physiology&Culture. Timber Press, USA.

Prof. Rajendra Singh (Rajju Bhaiya) University, Naini, Prayagraj

HORT-522: PRODUCTION OF WARM SEASON VEGETABLE CROPS 3(2+1)

WHY THIS COURSE?

Unlike cool-season vegetables, warm-season vegetable crops require higher soil and air temperature, thus, they are always planted after the last frost date ranging from late spring after the last frost date to late summer. Daytime temperature may still be warm enough but drop so much at night-time that the weather is not suitable for warm-season crops any longer. In general summer vegetables require a little higher temperature than winter vegetables for optimum growth. In summer vegetables, the edible portion is mostly botanical fruit. The students of vegetable science need to have an understanding of production technology of important warm season vegetable crops and thereafter their management.

AIM OF THIS COURSE:

To impart knowledge and skills on advancement in production technology of warm season vegetable crops

The course is constructed given as under:

No.	Block	Unit
1.	Production of warm season vegetable crops	1. Fruit vegetables
		2. Beans
		3. Cucurbits
		4. Tuber crops
		5. Leafy vegetables

LEARNING OUTCOMES

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of warm season vegetable crops in India
- Acquire knowledge about the production technology and post-harvest handling of warm season vegetable crops
- Calculate the economics of vegetable production in India

THEORY

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for

yield and quality, commercial varieties/hybrids, seed rate and seed treatment, raising of nursery including grafting technique, sowing/planting time and methods, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices namely hydroponics, aeroponics, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marking), pest and disease management and economics of crops.

Unit I: Fruit vegetables- Tomato, brinjal, hot pepper, sweet pepper and okra

Unit II: Beans- French bean, Indian bean (Sem), cluster bean and cowpea

Unit III: Cucurbits- Cucumber, melons, gourds, pumpkin and squashes

Unit IV: Tuber crops- Sweet potato, elephant foot yam, tapioca, taro and yam Unit

V: Leafy vegetables- Amaranth and drumstick

PRACTICAL

1. Scientific raising of nursery and seed treatment
2. Sowing, transplanting, vegetable grafting
3. Description of commercial varieties and hybrids
4. Demonstration on methods of irrigation, fertilizers and micronutrients application
5. Mulching practices, weed management
6. Use of plant growth substances in warm season vegetable crops
7. Study of nutritional and physiological disorders
8. Studies on hydroponics, aeroponics and other soilless culture
9. Identification of important pest and diseases and their control
10. Preparation of cropping scheme for commercial farms
11. Visit to commercial farm, greenhouse/polyhouses
12. Visit to vegetable market
13. Analysis of benefit to cost ratio

TEACHING METHODS/ACTIVITIES

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures

- Group discussion

SUGGESTED READINGS

- Bose, T.K., Kabir, J., Maity, T.K., Parthasarathy, V.A. and Som, M.G., 2003, Vegetable crops. Vols. I-III. Naya Udyog.
- Bose, T.K., Som, M.G. and Kabir, J. (Eds.), 1993, Vegetable crops. Naya prokash.
- Chadha, K.L. and Kalloo, G. (Eds.), 1993-94, Advances in horticulture Vols. V-X. Malhotra publ. house.
- Chadha, K.L. (Ed.), 2002, Hand book of horticulture. ICAR.
- Chauhan, D.V.S. (Ed.), 1986, Vegetable production in India.
- Ram prasad and sons. Fageria, M.S., Choudhary, B.R. and Dhaka, R.S., 2000, Vegetable crops: production technology. Vol. II. Kalyani.
- Gopalakrishanan, T.R., 2007, Vegetable crops. New India publ. agency.
- Hazra, P. and Banerjee, M. K. and Chattopadhyay, A. (2012), Varieties of vegetable crops in India, (Second edition), Kalyani publishers, Ludhiana , 199 p
- Hazra, P., 2016, Vegetable science. 2ndedn, Kalyani publishers, Ludhiana.
- Hazra, P., 2019, Vegetable production and technology. New India publishing agency, New Delhi.
- Hazra, P., Chattopadhyay, A., Karmakar, K. and Dutta, S., (2011),Modern technology for vegetable production, New India publishing agency, New Delhi, 413p
- Rana, M.K., 2008, Scientific cultivation of vegetables. Kalyani publ.
- Rubatzky, V.E. and Yamaguchi, M. (Eds.), 1997, World vegetables: principles, production and nutritive values. Chapman and Hall.
- Saini, G.S., 2001, A text book of oleri and flori culture. Aman publishing house.
- Salunkhe, D.K. and Kadam, S.S. (Ed.), 1998, Hand book of vegetable 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. (Ed.), 1989, Production technology of vegetable crops. Agril. comm. res. centre.
- Thamburaj, S. and Singh, N. (Eds.), 2004, Vegetables, tuber crops and spices. ICAR.
- Thompson, H.C. and Kelly, W.C. (Eds.), 1978, Vegetable crops. Tata McGraw-Hill.

Prof. Rajendra Singh (Rajju Bhaiya) University, Naini, Prayagraj

HORT-523: PROTECTED CULTIVATION OF HORTICULTURAL CROPS 2(1+1)

WHY THIS COURSE?

India is the second largest producer of vegetable crops in the world. However, its vegetable production is much less than the requirement, if a balanced diet is provided to every individual. There are different ways and means to achieve this target. Protected cultivation, which is the modification of the natural environment to achieve optimum plant growth. Is the most intensive form of crop production with a yield per unit area up to ten times superior to that of a field crop. During winter under north-east Indian conditions, it is difficult to grow tomato, capsicum, cucurbits, French bean, amaranth, etc. in open field. However, various types of protected structure have been developed for growing some high value crops by providing protection from the excessive cold. Production of off-season vegetable nurseries under protected structure has become a profitable business. The main purpose of raising nursery plants in protected structure is to get higher profit and disease free seedlings in off-season to raise early crop in protected and open field condition. The low cost polyhouse is economical for small and marginal farmers, who cannot afford huge cost of high-tech polyhouse.

Protected cultivation is more rewarding in production of high value cut flowers. With appropriate structures and plant environment control measures, the constraints of environment prevalent in the region can be overcome allowing almost year-round cultivation. The students need a thorough understanding of principles, types, designs, crops for different environments and management of environment in protected cultivation.

AIM OF THIS COURSE

To impart latest knowledge about growing of vegetable crops under protected environmental conditions .The course is constructed given as under:

S.No.	Block	Unit
1	Protected cultivation of vegetable crops	1. Scope and importance
		2. Types of protected structure
		3. Abiotic factors
		4. Nursery raising
		5. Cultivation of crops
		6. Solutions to problems
2	Protected cultivation of flowers crops	1.Control of environment
		2. Crop management and crop regulation

LEARNING OUTCOMES

After successful completion of this course, the students are expected to:

- Appreciate the scope and scenario of protected cultivation of vegetable crops in India
- Acquire knowledge about the effect of abiotic factors on growth, flowering and production of vegetable crops
- Gaining knowledge about the designing of various low cost protected structures
- Adopting the raising of vegetable seedlings in low cost protected structures as entrepreneur

THEORY

UNIT I: Scope and importance- Concept, scope and importance of protected cultivation of vegetable crops; Principles, design, orientation of structure, low and high cost polyhouses/greenhouse structures

UNIT II: Types of protected structure- Classification and types of protected structures-greenhouse/polyhouses, plastic-non plastic low tunnels, plastic walk in tunnels, high roof tunnels with ventilation, insect proof net houses, shed net houses, rain shelters, NVP, climate control greenhouses, hydroponics and aeroponics; Soil and soilless media for bed preparation; Design and installation of drip irrigation and fertigation system

UNIT III: Abiotic factors- Effect of environmental factors and manipulation of temperature, light, carbon dioxide, humidity, etc. on growth and yield of different vegetables.

UNIT IV: Nursery raising- High tech vegetable nursery raising in protected structures using plugs and portrays, different media for growing nursery under protected cultivation; Nursery problems and management technologies including fertigation

UNIT V: Cultivation of crops- Regulation of flowering and fruiting in vegetable crops; Technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, including varieties and hybrids, training, pruning and staking in growing vegetables under protected structures

UNIT VI: Solutions to problems- Problems of growing vegetables in protected structures and their remedies, physiological disorders, insect and disease management in protected structures; Use of protected structures for seed production; Economics of greenhouse crop production

PRACTICAL

1. Study of various types of protected structure
2. Study of different methods to control temperature, carbon dioxide and light
3. Study of different types of growing media, training and pruning systems in greenhouse crops
4. Study of fertigation and nutrient management under protected structures
5. Study of insect pests and diseases in greenhouse and its control
6. Use of protected structures in hybrid seed production of vegetables
7. Economics of protected cultivation (Any one crop)
8. Visit to established green/polyhouses/shade net houses in the region

TEACHING METHODS/ACTIVITIES

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

SUGGESTED READINGS

- Chadha, K.L. and Kalloo, G. (Eds.), 1993-94, Advances inhorticulture. Malhotra Pub. House.
- Chandra, S. and Som, V., 2000, Cultivating vegetables in green house. Indian horticulture 45:17-18.
- Kalloo, G. and Singh, K. (Eds.), 2000, Emerging scenario in vegetable research and development. Research periodicals and Book publ. house.
- Parvatha, R. P., 2016, Sustainable crop protection under protected cultivation. E-Book Springer.
- Prasad, S. and Kumar, U., 2005, Greenhouse management for horticultural crops. 2nd Ed.Agrobios.
- Resh, H.M., 2012, Hydroponic food production. 7thEdn. CRC Press.
- Singh, B., 2005, Protected cultivation of vegetable crops. Kalyani publishers, New Delhi
- Singh, D.K. and Peter, K.V., 2014, Protected cultivation of horticultural crops (1st Edition) New India publishing agency, New Delhi.

- Singh, S.,Singh, B. and Sabir, N., 2014, Advances in protected cultivation. New India publishing agency, New Delhi.
- Tiwari, G.N., 2003, Green house technology for controlled environment. Narosa publ. house.
- Bhattacharjee, S. K. 2018. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Reprint, pp. 2065.
- Bose, T.K., Maiti, R.G., Dhua, R.S. & Das, P. 1999. Floriculture and Landscaping. Naya Prokash, Kolkata, India.
- Bose, T. K. & Yadav, L. P. 1989. Commercial Flowers. Naya Prokash, Kolkata, India.
- Chadha, K. L. & Bhattacharjee, S.K. 1995. Advances in Horticulture: Ornamental Plants. Vol.
- XII, Parts 1 & 2. pp.533 & pp.574. Malhotra Publ. House, New Delhi, India. \
- Lauria, A. & Victor, H.R. 2001. Floriculture-Fundamentals and Practices. Agrobios Publ., Jodhpur.
- Nelson PV. 2011. Green House Operation and Management. Pearson Publ. 7th edition, pp. 624.
- Prasad, S. & Kumar, U. 2003. Commercial Floriculture. Agrobios Publ., Jodhpur.
- Randhawa, G.S. & Mukhopadhyay, A. 1986. Floriculture in India. Allied Publ.
- Reddy, S., Janakiram, T., Balaji T., Kulkarni, S. &Misra, R. L. 2007. Hi- Tech Floriculture. Indian Society of Ornamental Horticulture, New Delhi, India

STAT-511: EXPERIMENTAL DESIGNS 3(2+1)

AIM OF THE COURSE

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

THEORY

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

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

Unit III : Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.

Unit IV : Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications, Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

PRACTICAL

- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, Analysis of data obtained from CRD, RBD, LSD, Analysis of factorial experiments,
- Analysis with missing data,
- Split plot and strip plot designs.

SUGGESTED READINGS

- Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
- Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.
- Montgomery DC. 2012. Design and Analysis of Experiments, 8th Ed. John Wiley.
- Federer WT. 1985. Experimental Designs. MacMillan.
- Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
- Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
- Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
- www.drs.icar.gov.in.

STAT-512: STATISTICAL METHODS FOR APPLIED SCIENCES 3(2+1)

AIM OF THE COURSE

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

THEORY

Unit I: Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation.

Unit II : Discrete and continuous probability distributions, Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions.

Unit III: Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination, Fitting of quadratic models.

Unit IV : Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test.

Unit V : Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Introduction to Multivariate Analysis, Transformation of Data.

PRACTICAL

• Exploratory data analysis, fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal.

• Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F.

• Confidence interval estimation and Correlation and regression analysis, fitting of Linear and Quadratic Model.

• Non-parametric tests. ANOVA: One way, Two Way, SRS.

SUGGESTED READINGS

- Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.
- Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.
- Hoel P.G. 1971. Introduction to Mathematical Statistics. John Wiley.
- Hogg R.V and Craig T.T. 1978. Introduction to Mathematical Statistics. Macmillan.
- Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.
- Hogg RV, McKean JW, Craig AT. 2012. Introduction to Mathematical Statistics 7th Edition.
- Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.
- Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed . John Wiley

PGS-503: INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (1+0)

OBJECTIVE

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

THEORY

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

SUGGESTED READINGS

1. Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.

2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.

3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.

4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.

5. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.

6. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

PGS -504: BASIC CONCEPTS IN LABORATORY TECHNIQUES (0+1)

OBJECTIVE

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

PRACTICAL

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

• Neutralisation of acid and bases;

• Preparation of buffers of different strengths and pH values;

• Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;

• Electric wiring and earthing;

• Preparation of media and methods of sterilization;

• Seed viability testing, testing of pollen viability;

• Tissue culture of crop plants;

• Description of flowering plants in botanical terms in relation to taxonomy.

SUGGESTED READINGS

1. Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
2. Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

SEMESTER -III

HORT-515 : COMMERCIAL PRODUCTION OF CUT AND LOOSE FLOWERS

3(2+1)

WHY THIS COURSE?

Cut flowers are grown in a wide variety of environments and agroclimatic regions. The students of floriculture need to have an understanding of production and post-harvest management of important cut flower crops on a commercial scale.

AIM OF THIS COURSE

To impart basic knowledge about the importance and production dynamics of cut flowers grown in India. The course is organized as follows

No	Blocks	Units
1	Production management	1. Scope and scenario
		2. Growing environment
		3. Crop Management
		4. Flower regulation
2	Post harvest management and marketing	1. Post harvest management
		2. Marketing

LEARNING OUTCOMES

After successful completion of this course, the students are expected to be

- Understand the scope and scenario of floriculture
- thorough understanding of production and post harvest management of flower crops.
- Acquire the required skills to prepare project reports on different crops for financing.

THEORY

Block 1: Production management

UNIT I: Scope and scenario: National and International scenario, importance and scope of cut flower trade, constraints for cut flower production in India.

UNIT II: Growing environment: Soli analysis, soil health card, Growing environment, open cultivation, protected cultivation, soil/media requirements, land preparation, planting methods, influence of light, temperature, moisture, humidity and microclimate management on growth and flowering.

UNIT III: Crop management: Commercial Flower production – Commercial varieties, water and nutrient management, fertigation, weed management, crop specific practices, ratooning, training and pruning, pinching, deshooting, bending, desuckering, disbudding. Use of growth regulators, physiological disorders and remedies, IPM and IDM.

UNIT IV: Flower regulation: Flower forcing and year round/offseason flower production through physiological interventions, chemical regulation, environmental manipulation.

Block 2: Post harvest management and marketing

UNIT I: Post harvest management: Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Precooling, pulsing, packing, storage and transportation.

UNIT II: Marketing: Marketing, export potential, institutional support, Agri Export Zones, 100% Export Oriented units, Crop Insurance

Crops :

Rose, chrysanthemum, gladiolus, tuberose, carnation, gerbera, orchids, lilium, anthurium, China aster, alstroemeria, bird of paradise, heliconia, alpinia, ornamental ginger, dahlia, gypsophila, solidago, limonium, stock, cut greens and fillers.

Crops:

Rose, jasmine, chrysanthemum, marigold, tuberose, China aster, crossandra, gaillardia, spider lily, hibiscus, Nerium, barleria, celosia, gomphrena, Madar (Calotropis gigantea), nyctanthes (Harsingar), Ervatamia (Chandni), ixora, lotus, water lily, Michelia (Champa), gardenia, Ixora and balsam

PRACTICALS

1. Identification of varieties
2. Propagation
3. Microclimate management
4. Training and pruning techniques
5. Pinching, deshooting, disbudding, desuckering
6. Practices in manuring, drip and fertigation, foliar nutrition, growth regulator application

7. Harvesting techniques, post-harvest handling, cold chain
8. Economics, Project preparation for regionally important cut flowers, crop specific guidelines for project financing (NHB guidelines)
9. Visit to commercial cut flower units
10. Case studies

TEACHING METHODS/ACTIVITIES

- Lectures
- Group discussions
- Flip classes
- Assignment and student presentation
- Hands on training of different procedures
- Exposure visits

SUGGESTED READINGS

- Arora, J.S. 2010. Introductory Ornamental Horticulture. Kalyani Publishers. 6th edition, pp.230.
- Bhattacharjee, S. K. 2018. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Reprint, pp. 2065.
- Bose, T. K., Maiti, R. G., Dhua, R. S. & Das, P. 1999. Floriculture and Landscaping.
- Prokash, Kolkata, India. Bose, T. K. & Yadav, L.P. 1989. Commercial Flowers. Naya Prokash, Kolkata, India.
- Chadha, K. L. & Bhattacharjee, S.K. 1995. Advances in Horticulture: Ornamental Plants. Vol. XII, Parts 1 & 2. pp. 533, pp. 574. Malhotra Publ. House, New Delhi, India.
- Chadha, K. L. & Chaudhury, B. 1992. Ornamental Horticulture in India. ICAR, New Delhi, India.
- Dole, J. M. & Wilkins, H. F. 2004. Floriculture-Principles and Species. Prentice Hall. 2nd edition, pp. 1048.
- Larson, R. A. 1980. Introduction to Floriculture. New York Academic Press. pp. 628.
- Laurie, A. & Rees V, H. 2001. Floriculture-Fundamentals and Practices. Agrobios Publications, Jodhpur. pp.534.

- Prasad, S. & Kumar, U. 2003. Commercial Floriculture. Agrobios Publications, Jodhpur.
- Randhawa, G. S. & Mukhopadhyay, A. 2001. Floriculture in India. Allied Publ. pp 660.
- Reddy S, Janakiram T, Balaji , Kulkarni S. &Misra RL. 2007. Hi- Tech Floriculture. Indian Society of Ornamental Horticulture, New Delhi, India.
- Singh, A. K. 2006. Flower Crops: Cultivation and Management. New India Publ. Agency, New Delhi, India. pp. 475.

HORT-516: POSTHARVEST MANAGEMENT AND PRESERVATION OF FRUITS AND VEGETABLE 3(2+1)

WHY THIS COURSE?

Fruits and vegetables are perishable crops that suffer great losses both in quantity and quality after harvest. These produce require integrated approach to arrest their spoilage and overcome the present day challenges that assimilates millions of tons annually. Lack of postharvest awareness and absence of sufficient and functioning equipment in the postharvest chain result in serious postharvest losses in developing countries. Clear and comprehensive understanding of postharvest deteriorative factors is necessary to overcome these challenges. Pre and postharvest management such as good cultural practices, use of improved varieties, good handling practices pre and postharvest, temperature and relative humidity management, storage atmosphere management, use of permitted chemicals, design of appropriate packaging materials and storage structures are some of the control measures use in reducing postharvest losses. Hence this customized course

AIM OF THIS COURSE:

To impart comprehensive knowledge on management of horticultural produce thus extending the post-harvest life of the produce by various treatments.

The course is organized as follows

No	Blocks	Units
1	Postharvest management of horticultural produce	1. Importance and scope of management and processing
		2. Regulation of ripening and spoilage
		3. Treatments for extending shelf life
		4.Handling system and marketing of horticultural crops
		5. Preservation of fruit and vegtables

LEARNING OUTCOMES:

After successful completion of this course, the students are expected to be able to understand:

- Regulation of ripening by use of chemicals and growth regulators
- Pre and Postharvest treatments for extending storage life/vase life
- Standards and specifications for fresh produce
- Understand Principles and different methods of preservation
- Principal spoilage organisms, food poisoning and their control measures
- Canning of fruits and vegetables
- Processing equipment's and layout of processing industry

THEORY:

Block 1:

Postharvest Management of Horticultural Produce

UNIT-I: History, Importance and scope of Postharvest technology of horticultural produce. Nature and structure of horticultural produce. Pre and Postharvest losses and their causes.

UNIT-II: Climacteric and non-climacteric fruits. Regulation of ripening by use of chemicals and growth regulators. Control of sprouting, rooting and discoloration in vegetables.

UNIT-III: Maturity indices for harvest. Harvesting and harvesting tools. Curing in roots and tubers. Prepackage Operation: Precooling, washing, sorting, grading of horticulturalperishables for local markets and export. Postharvest handling of spices, plantation crops, medicinal and aromatic plants. Equipments for washing, sizing, grading.

UNIT-IV: Pre and Postharvest treatments for extending storage life/vase life. VHT, irradiation treatment, skin coating, degreening etc. Pre-packaging, Packaging techniques for local market and export. Standards and specifications for fresh produce.

UNIT-V : Postharvest handling system for horticulture crops of regional importance.

Block 2:

Principles and Methods of Fruit and Vegetable Processing

UNIT-I: Introduction, Historical development in food processing, type of food and causes for food spoilage. Basic principles of fruits and vegetables processing;

UNIT-II: Effects of low temperature on fresh commodities and prepared product. Freezing preservation, freezing points of foods, slow and quick freezing, Cryogenic freezing and frozen food storage. Drying and dehydration, sun drying solar dehydration, mechanical drying types of driers, osmotic dehydration.

UNIT-III: Food fermentation – alcoholic, acetic and lactic fermentation. Pickling and curing; Effect of salt on food preservation, types of salt cured products. Traditional and new products; chemical preservation, SO2, benzoic acid, sorbic acid, antioxidants and antibiotics, newer preservatives. Preservation by controlling water activity – high sugar products, intermediate moisture food, food concentration.

PRACTICALS:

1. Study of maturity indices for harvest of fruits, vegetables, spices and plantation crops.
2. Protective skin coating with wax emulsion and pre and Postharvest treatment with fungicides, chemicals and growth regulators to extend the shelf life of fruits and vegetables.
3. Pre-packaging of perishables
4. Study of effect of pre-cooling on shelf-life and quality of fresh fruits, vegetables and flowers.
5. Visit to local markets, cooperative organizations, super markets dealing with marketing of Perishables.
6. Preparation and preservation of fruit based beverages and blended products from fruits and vegetables.
7. Preparation of dehydrated vegetables.

TEACHING METHODS / ACTIVITIES

- Lectures
- Assignments (Reading/Writing)
- Exposure visits
- Student presentation
- Group Work /seminars

SUGESTED READINGS

- Thompson A. K. (Ed.) (2014) Fruit and Vegetables: Harvesting, Handling and Storage (Vol. 1 & 2) Blackwell Publishing Ltd, Oxford, UK. ISBN: 9781118654040.
- Wills R. B. H. and Golding, J. (2016) Postharvest: an introduction to the physiology and handling of fruit and vegetables, CABI Publishing, ISBN 9781786391483.
- Wills R. B. H. and Golding, J. (2017) Advances in Postharvest Fruit and Vegetable Technology, CRC Press, ISBN 9781138894051.
- Sudheer K.P., Indira V (2007) Postharvest Technology of Horticultural Crops, Peter K.V. (Ed.), New India Publishing Agency, ISBN 9788189422431.
- Sunil Pareek (Ed.) (2016) Postharvest Ripening Physiology of Crops, CRC Press, ISBN 9781498703802.
- Paliyath G., Murr D. P., Handa, A. K. and Lurie S. (2008) Postharvest Biology and Technology of Fruits, Vegetables and Flowers, Wiley-Blackwell, ISBN: 9780813804088.
- Verma, L. R. and Joshi, V. K. (2000) Postharvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management. Indus Publishing Company, New Delhi, India. ISBN 8173871086.
- Bhattacharjee S. K, and Dee L. C. (2005). Postharvest technology of flowers and ornamental plants. Pointer publishers, Jaipur.
- Chattopadhyay S. K.(2007) Handling, transportation and storage of fruit and vegetables. Gene- Tech books, New Delhi.
- FAO.2007. Handing and Preservation of Fruits and Vegetables by Combined methods for Rural Areas-Technical Manual. FAO Agr.Ser.Bull., 149.
- Kader A. A. 1992. Postharvest technology of horticultural crops. 2nd ed university of California.

- Pruthi J. S. 2001 (Reprint). Major spices of India crop management and Postharvest technology. ICAR, New Delhi
- Stawley J. Kays. 1998. Postharvest physiology of perishable plant products. CBS publishers. Websites:
- Horticulture-Post harvest management CSIR-NISTADS http://www.nistads.res.in/indiasnt2008/t6rural/t6rur13.htm
- Post harvest technology- MANAGE http://www.manage.gov.in/ftf-itt/prgReports/iihr.pdf
- Role of post-harvest management http://www.fao.org/3/y5431e/y5431e02.htm

HORT-518: BREEDING OF HORTICULTURAL CROPS 3(2+1)

WHY THIS COURSE?

Self-pollination, which is considered the highest degree of inbreeding a plant can achieve, promotes homozygosity of all gene loci and traits of the sporophyte and restricts the creation of new gene combinations (no introgression of new genes through hybridization). The progeny of a single plant is homogeneous due to self pollination. A population of self-pollinated species comprises a mixture of homozygous lines. New genes may arise through mutation but such change is restricted to individual lines or the progenies of the mutant plant. Since a self-pollinated cultivar is generally one single genotype reproducing itself, breeding of self-pollinated species usually entails identifying one superior genotype (or a few) and its multiplication. Specific breeding methods commonly used for self-pollinated species are pure-line selection, pedigree breeding, bulk populations and backcross breeding. The students of horticulture who take breeding as a minor subject need to have an understanding of breeding of horticultural crops.

AIM OF THIS COURSE

To impart comprehensive knowledge about principles and practices of breeding of self-pollinated vegetable crops .

The course is constructed given as under:

No.	Block	Unit
1	Breeding of vegetable crops	Cool & Summer vegetables
2	Breeding of fruit crop	Major fruits
3	Breeding of Ornamental crops	Commercial flowers

LEARNING OUTCOMES

- After successful completion of this course, the students are expected to:
- Acquire knowledge about the breeding of self-pollinated vegetable crops
- Improve yield, quality, abiotic and biotic resistance and other important traits of vegetable fruits and ornamental crops
- Understand how to start the breeding of crops

THEORY

Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination and fertilization mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, breeding for protected environment and quality improvement, molecular markers and marker's assisted breeding; QTLs, PPV and FR Act.

BLOCK-1: Breeding of vegetable crops

Unit I: Tomato, eggplant, hot pepper, sweet pepper and okra

Unit II: Leguminous vegetables- Garden peas and beans

BLOCK-2: Breeding of fruit crops

Unit IV: Mango, Banana, Pineapple, Citrus, Grapes, Litchi, Guava, Pomegranate, Papaya, Apple, Pear, Plum, Peach, Apricot, Cherries, Strawberry, Kiwifruit, Nuts

BLOCK-3: Breeding of ornamental crops

Unit V: Rose, chrysanthemum, carnation, gerbera, gladiolus, orchids, anthurium, lilium, marigold, jasmine, tuberose, dahlia, gaillardia, crossandra, aster etc., Flowering annuals: petunia, zinnia, snapdragon, stock, pansy, calendula, balsam, dianthus etc. Important ornamental crops like aglaonema, diffenbachia, hibiscus, bougainvillea, kalanchoe etc.

PRACTICAL

1. Floral mechanisms favouring self and often cross pollination

2. Progeny testing and development of inbred lines

3. Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations

4. Palynological studies, selfing and crossing techniques

5. Hybrid seed production of vegetable crops in bulk

6. Screening techniques for biotic and abiotic stress resistance in above mentioned crops

7. Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques 8. Visit to breeding farms

TEACHING METHODS/ACTIVITIES

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedures
- Group discussion

SUGESTED READINGS

- Allard, R.W., 1999, Principles of plant breeding. John Wiley and Sons. Basset, M.J. (Ed.), 1986, Breeding vegetable crops. AVI Publ. Dhillon, B.S., Tyagi, R.K., Saxena, S. and Randhawa, G.J., 2005, Plant genetic resources: horticultural crops. Narosa Publ. House.
- Abraham, Z. 2017. Fruit Breeding. Agri-Horti Press, New Delhi.
- Badenes, M. L. and Byrne, D. H. 2012. Fruit Breeding. Springer Science, New York.
- Dinesh, M. R. 2015. Fruit Breeding, New India Publishing Agency, New Delhi. Ghosh, S. N. Verma, M. K. and Thakur, A. 2018. Temperate Fruit Crop Breeding- Domestication to Cultivar Development. NIPA, New Delhi.

- Hancock, J. F. 2008. Temperate Fruit Crop Breeding: Germplasm to Genomics. Springer Science, New York.
- Jain, S. N. and Priyadarshan, P. M. 2009. Breeding Plantation and Tree Crops: Tropical Species. Springer Science, New York.
- Jain, S. and Priyadarshan, P. M. 2009. Breeding Plantation and Tree Crops: Temperate Species. Springer Science, New York.
- Janick, J. and Moore, J. N. 1996. Fruit Breeding. Vols. I - III. John Wiley & Sons, USA.
- Kumar, N. 2014. Breeding of Horticultural Crops: Principles& Practices. NIPA, N. Delhi.
- Moore, J. N. and Janick, J. 1983. Methods in Fruit Breeding. Purdue University Press, USA. Ray. P. K.2002. Breeding Tropical and Subtropical Fruits.Narosa Publ. House, New Delhi.

COMP-501 : COMPUTER FUNDAMENTALS AND PROGRAMMING 3(2+1)

AIM OF THE COURSE

This is a course on Computer Fundamentals and Programming that aims at exposing the students to understand how computer works, analytical skills to solve problems using computers. and to write computer programs using

THEORY

Unit I: Functional units of computer, I/O devices, primary and secondary memories. Number systems: decimal, octal, binary and hexadecimal; Representation of integers, fixed and floating point numbers, Operator precedence, character representation; ASCII, Unicode.

Unit II: Programming Fundamentals with C - Algorithm, techniques of problem solving, flowcharting, stepwise refinement; Constants and variables; Data types: integer, character, real, data types; Arithmetic expressions, assignment statements, logical expressions. Control flow

Unit III: Arrays and structures. Pointers, dynamic memory allocations Unit IV Program Structures – functions, subroutines Unit V I/O operations, Program correctness; Debugging and testing of programs.

PRACTICAL

• Conversion of different number types;

• Creation of flow chart, conversion of algorithm/flowchart to program;

• Mathematical operators, operator precedence;

• Sequence, control and iteration;

• Arrays and string processing;

• Matrix operations, Sorting, Pointers and File processing – Reading and writing text files.

SUGGESTED READINGS

• Bala Guruswamy E. 2019. Programming with ANSI C. Tata McGraw Hill.

• Gottfried B. 2017. Programming with C, Schaum Outline Series. Tata McGraw Hill.

• Kanetkar Y. 1999. Let Us C. BPB Publ.

PGS-505 - AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES 1 (1+0)

OBJECTIVE

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

THEORY

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

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

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

SUGGESTED READINGS

1. Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.

2. Punia MS. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
4. Singh K. 1998. Rural Development - Principles, , Policies and Management. Sage Publ.

Prof. Rajendra Singh (Rajju Bhaiya) University, Naini, Prayagraj

SELECTED JOURNAL LIST

Sl. No.	Name of the Journal	ISSN Number
1	American Journal of Horticultural Sciences	0003-1062
2	American potato growers	
3	American Scientist	1545-2786
4	Annals of Agricultural Research	9703179
5	Annual Review of Plant Physiology	0066-4294
6	California agriculture	1097-0967
7	Haryana journal fof horticultural sciences	0970-2873
8	HAU Journal of research	0379-4008
9	Horticulture Research	2052-7276
10	Hort Science	2327-9834
11	IIVR Bulletins	1462-0316
12	Indian Horticulture	0019-4875
13	Indian Journal of agricultural sciences	0019-5022
14	Indian Journal of Horticulture	0974-0112
15	Indian journal of plant physiology	2662-2548
16	Journal of American society for Horticultural sciences	0003-1062
17	Journal of arecanut and spice crops	
18	Journal of food science and Technology	0975-8402
19	Journal of Plant Physiology	0176-1617
20	Journal of postharvest biology and technology	0925-5214
21	Postharvest biology and technology	0925-5214
22	Scientia Horticulturae	0304-4238
23	Seed Research	2151-6146
24	Seed science	23171537
25	South Indian Horticulture	0038-3473
26	Vegetable grower	2330-2321
27	Vegetable Science	2455-7552