Course Curricula for Undergraduate programme

In

Horticulture

(UG- Certificate in Horticulture /

UG-Diploma in Horticulture /

B.Sc. (Hons) Horticulture)

[As per 6th Deans Committee Recommendations]

BIDHAN CHANDRA KRISHI VISWAVIDYALAYA
Faculty of Horticulture
P.O: Krishi Viswavidyalaya, Dist. Nadia-741252
West Bengal, India

COURSE CURRICULA FOR UNDERGRADUATE PROGRAMME IN HORTICULTURE

Sl. No.	Course No.	Course Title	Credit Hours	Total Credit	Departments offering
FIRST YEAR					
SEMESTER-I					
1	CC-101	Deeksharambh (Non-Gradial)	2 (0+2)	**21** (CC*: 6 + 2 non-gradial + Core Course: 11 + SEC**: 4) **Note:** *CC: Common Course **SEC: Skill Enhancement Course	All Deans & Secretaries, F/Council
2	CC-102	Communication Skills	2 (1+1)		AEX
3	CC-103	Environmental Studies and Disaster Management	3 (2+1)		AMP & ACSS
4	CC-104	National Service Scheme (NSS)-I	1 (0+1)		NSS
5	Hort-105	Fundamentals of Horticulture	3 (2+1)		Fruit Sci. & Veg. Sci.
6	Hort-106	Plant Propagation and Nursery Management of Fruit and Plantation Crops	3 (1+2)		Fruit Sci. & PSMA
7	Hort-107	Commercial production of flower crops	3 (1+2)		FLA
8	Hort -108	Sprinkler and micro irrigation system	2 (1+1)		PSMA, AGR, ACSS
9	SEC (I) - 109	Vermicompost Production	2 (0+2)		Agronomy (AGR)
	SEC (I) - 110	Production of Ornamental fish and aquarium plants	2 (0+2)		ASC
10	SEC (II)- 111	Mushroom Production	2 (0+2)		PPA
	SEC (II)- 112	Seed Production Technology of vegetable Crops	2 (0+2)		Veg. Sc.
SEMESTER-II					
1	CC-151	Farming based Livelihood systems	3 (2+1)		AGR, Hort, ASC, AEX, AEC

2	CC-152	Personality Development	2 (1+1)	**19** (CC: 6 + Core Course: 9 + SEC: 4)	AEX
3	CC-153	National Service Scheme (NSS)-II	1 (0+1)		NSS
4	AGR(H)-154	Introduction to major field crops	3 (2+1)		AGR
5	Hort-155	Commercial Production of Spices and Plantation Crops	3 (1+2)		PSMA
6	Hort-156	Plant Propagation and Nursery Management in Vegetable, Flower and Medicinal crops	3 (1+2)		Veg. Sci., FLA, PSMA
7	SEC (III) 161	Soil, water and plant testing	2(0+2)		ACSS
	SEC (III) 162	Apiculture	2(0+2)		AEN
	SEC (III) 163	Orchard floor management	2(0+2)		Fruit Sci.
8	SEC (IV) 164	Agro forestry management	2(0+2)		SWC
	SEC (IV) 165	Organic production technology	2(0+2)		AGR
	SEC (IV) 166	Nursery production of horticultural crops	2(0+2)		Fruit, Veg Sc., FLA, PSMA
Post-II Semester					
1.	Internship (for 10 weeks only for exit option for award of UG certificate)		10(10+0)	10	
SECOND YEAR					
SEMESTER-III					
1	CC-201	Physical Education, First Aid, Yoga Practices and Meditation	2(0+2)	**21** (CC: 2 + Core Course: 17 + SEC: 2)	By all Faculties
2	ACSS(H)-202	Fundamentals of Soil Science	3 (2+1)		ACSS
3	Hort-203	Urban and Peri Urban Horticulture	2 (1+1)		FLA, Veg. Sci.
4	Hort-204	Precision Farming and Protected Cultivation	3 (2+1)		Veg. Sc. FLA

5	Hort-205	Seed Production of Vegetable, Tuber and Spice Crops	3 (2+1)		Veg. Sc., PSMA
6	FMP(H)-206	Farm Power and Machinery for Horticulture	3 (2+1)		FMP (Ag. Engg.)
7	PPA(H)-207	Disease Management of Horticulture Crops	3 (2+1)		PPA
8	SEC (V)-211	Production technology of Bioagents	2(0+2)		AEN
	SEC (V)-212	Production of Botanical Pesticides	2(0+2)		ACH
	SEC (V)-213	Post Harvest Management of Horticultural crops	2(0+2)		PHT
	SEC (V)-214	Seed production and processing technology	2(0+2)		SST
	SEC (V)-215	Molecular Data Analytics	2 (0+2)		ABT
SEMESTER-IV					
1	CC 251	Agricultural Informatics and Artificial Intelligence	3(2+1)	**21** (CC: 6 + Core Course: 13 + SEC: 2 + Non-gradial: 2)	AST
2	CC 252	Entrepreneurship Development and Business Communication	3(2+1)		AEC
3	Hort-253	Commercial Vegetable Production	4 (3+1)		Veg. Sci.
4	Hort-254	Commercial Fruit Production	4 (3+1)		Fruit Sci., PSMA
5	AEN(H)-255	Pest Management of Horticulture Crops	3 (2+1)		AEN
6	AMP(H)-256	Introductory Agro-meteorology and Climate Change	2 (1+1)		AMP
7	SEC (VI) 261	Micropropagation technologies	2(0+2)		GPB
	SEC (VI) 262	Landscape gardening	2(0+2)		FLA
	SEC (VI) 263	Biofertilizer production technology	2(0+2)		ACSS

	SEC (VI) 264	Production of Microbial Biocontrol agents	2(0+2)		PPA
Post-IV Semester					
1.	Internship (for 10 weeks only for exit option for award of UG Diploma)		10(0+10)	**10**	
THIRD YEAR					
SEMESTER-V					
1	CC 301	Agricultural Marketing and Trade	3(2+1)	**23** (CC: 3 + Core Course: 20)	AEC
2	GPB(H)-302	Fundamental of Plant Breeding	3 (2+1)		GPB
3	Hort-303	Growth and Development of Horticultural Crops	3 (2+1)		Veg. Sci., Fruit Sci., FLA, PSMA
4	ACSS(H)-304	Soil Fertility and Nutrient Management	3 (2+1)		ACSS
5	ACSS(H)-305	General Microbiology	3 (2+1)		ACSS, PPA
6	AST(H)-306	Information and Communication Technology in Horticulture	3 (1+2)		AST
7	PPH(H)-307	Introductory Crop Physiology	2 (1+1)		Plant Physio.
8	AST(H)-308	Basic Statistics and Experimental Design	3 (2+1)		AST
9	Hort-309	Educational tour (Non-gradial)	2(0+2)		Dean F/Hort.
SEMESTER-VI					
1	SWC(H)-351	Introductory Agroforestry	3 (2+1)	**22** (Core Course: 22)	SWC
2	Hort-352	Laboratory Techniques for Horticultural Crops	2 (0+2)		Fruit Sc., Veg Sc., PHT, FLA
3	ABC(H)-353	Principle of Biochemistry	3 (2+1)		ABC
4	Hort-354	Dryland Horticulture	3 (2+1)		Fruit Sc., ACSS, PSMA

5	AEC(H)-355	Economics and Marketing	3 (2+1)		AEC
6	AGR(H)-356	Principle and Practices of Natural Farming	2 (1+1)		AGR
7	Hort-357	Horticulture Based Integrated Farming System	3 (2+1)		Fruit Sci., Veg. Sci., PSMA, FLA
8	Hort-358	Processing and Value Addition of Horticulture crops	3 (2+1)		PHT
FOURTH YEAR					
SEMESTER-VII					
1		The Students will choose Elective Courses of 20 credits from any one discipline, which will be offered **(Restructuring of Elective Courses is needed)**	Elective Courses as per 6th Deans' committee placed in Table-1	20	
SEMESTER-VIII					
1	Student Ready (RAHWE/Industrial Attachment/Project Work/Internship)		20(0+20)	**20**	All Dept. of F/Hort.
Total				**167**	
Non-gradial (Deeksharambh & study tour)				**4***	
Internship for UG-Certificate or UG-Diploma				**10**	
Online Courses				**10****	
Grand Total				**167 + 4* + 10****	

Table 1. List of Elective Courses to be offered Discipline-wise as per 6th Deans' committee

ELECTIVE COURSES

Course No.	Course	Credits
Fruit Science		
Hort-401	Production Technology of Tropical Fruit crops	3 (2+1)
Hort-402	Production Technology of Sub tropical and Temperate Fruit crops	3 (2+1)
Hort-403	Breeding of Fruit Crops	3 (2+1)
Hort-404	Canopy Management in Fruit Crops	3 (2+1)
Hort-405	Biotechnological Approaches and Micro-propagation in Fruit Crops	3 (2+1)
Hort-406	Production Technology of Arid Fruit Crops	3 (2+1)
Hort-407	Postharvest Management of Fruit Crops	2 (1+1)
Vegetable Science		
Hort-408	Production Technology of Warm Season Vegetable Crops	3 (2+1)
Hort-409	Production Technology of Cool Season Vegetable Crops	3 (2+1)
Hort-410	Production Technology of Tuber Crops	3 (2+1)
Hort-411	Breeding of Vegetable Crops	3 (2+1)
Hort-412	Biotechnological approaches and Micropropagation in Vegetable Crops	3 (2+1)
Hort-413	Postharvest Management of Vegetable Crops	3 (2+1)
Hort-414	Protected cultivation of Vegetable Crops	2 (1+1)
Floriculture and Landscaping		
Hort-415	Turf management	2 (1+1)
Hort-416	Protected Cultivation of Flower Crops	3 (2+1)
Hort-417	Value Addition in Floriculture	3 (2+1)
Hort-418	Breeding of Ornamental Crops	3 (2+1)
Hort-419	Principles of Landscape Architecture	3 (2+1)
Hort-420	Commercial Floriculture and Landscaping	3 (2+1)
Hort-421	Postharvest handling of Floricultural Crops	3 (2+1)

Note: ***The University/ Institute may offer more electives/courses relevant to the subject.***

DETAILED SYLLABUS

SEMESTER I

CC- 101 DEEKSHARAMBH (Induction cum Foundation Program) 2 (0+2)

The activities to be taken under *Deeksharambh*, in addition to giving a broad view and application areas of the subject of study, also will aim at creating a platform for

- Helping students from different backgrounds for cultural Integration
- Knowing about the operational framework of academic process in University
- Instilling life and social skills, leadership qualities, team working spirit
- Developing social awareness, ethics and values, creativity
- Helping students to identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities/ schedules will be decided by the parent universities. The structure shall include, but not restricted to:

- Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
- Creating awareness on the subject of study, and the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario
- Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
- Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
- Field visits to related fields/ establishments
- Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

CC-102 COMMUNICATION SKILLS 2(1+1)

Objectives

1. To acquire competence in oral, written and non-verbal communication
2. To develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication. Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy

questions. Structural and Functional Grammar: Sentence structure, modifiers, connecting words an verbal's; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building

CC-103 ENVIRONMENTAL STUDIES & DISASTER MANAGEMENT 3(2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies: Definition, scope and importance -Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth- Lithosphere - Hydrosphere – Atmosphere - Different layers of atmosphere.

Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems: Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem.

Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.

Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution h. Light pollution.

Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis Biogas production, Causes, effects and control measures of urban and industrial wastes.

Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management.

Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention & control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act.

Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management: Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters: Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers,New Delhi ISBN:13–978 81 224 2617 5. 384 pp
2. Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi
4. Parthiban, K.T. Vennila, Prasanthrajan, S., Umesh, M. and Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India. (In Press).
5. Prasanthrajan M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition:2008
6. Prasanthrajan M. 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publications, Meerut, India
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

CC-104 NATIONAL SERVICE SCHEME (NSS-1) 1(0+1)

- Orientation: history, objectives, principles, symbol, badge; programs under NSS

- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NS volunteers' awareness about health.
- NSS program activities: Concept of regular activities, special camping, day camps, basis of adoption village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization: Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace building.Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights: Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community based organizations) and society

HORT 105 FUNDAMENTALS OF HORTICULTURE 3(2+1)

Objectives

1. To provide knowledge of horticulture in a brief and prescribed manner
2. To familiarize students with principles and practices of management for Horticultural crops

Theory

Scope and importance, classification of horticultural crops and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery techniques and their management, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management– irrigation methods, merits and demerits, weed management, fertility management in horticultural crops-manures and fertilizers, different methods of application, cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits, Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, principles of organic and Natural farming, market chain management.

Practical

Features of orchard, planning and layout of orchard, tools and implements, identification of various horticultural crops, layout of nutrition garden, preparation of nursery beds for sowing of vegetable/ flower seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer

mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits and vegetable crops, maturity standards, harvesting, grading, packaging and storage.

Suggested readings

1. Chattopadhyay T K 2013. A Textbook on Pomology Vol I-IV. Kalyani Publications. New Delhi.
2. Kumar Prasad 2014. Principles of Horticulture 2nd edn. Agrobios India.
3. Misra Kausal Kumar and Kumar Rajesh 2014. Fundamentals of Horticulture. Biotech Books.
4. Peter K V 2009. Basics Horticulture. New India Publishing Agency.
5. Salunkhe D K and Kadam S S 2013. A handbook of Fruit Science and Technology. CRC Press.
6. Singh Jitendra 2011. Basic Horticulture. Kalyani Publications. New Delhi.
7. Singh Neeraj Pratap 2005. Basic concepts of Fruit Science 1st edn. IBDC Publishers.

HORT 106 PLANT PROPAGATION & NURSERY MANAGEMENT OF FRUITS & PLANTATION CROPS 3(1+2)

Objectives

1. To know different methods of propagation techniques
2. Horticultural significance of specialized vegetative structures
3. To study the different types of plant propagation methods and structures

Theory

Status and importance of plant propagation and nursery production in fruits and plantation crops. Sexual and asexual methods of propagation, their advantages and disadvantages. Apomixes, seed dormancy, types of dormancy and methods to overcome seed dormancy. Use of vegetative propagation methods viz. division, cutting, layering, budding and grafting. Propagation structures in nursery production: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds and poly-houses. Use of growth regulators in nursery production. Components of a nursery, maintenance of mother trees and seed gardens, collection of scion-wood, and bud wood certification.
Growing medium and containers used for nursery production. Role of tissue culture techniques viz. micropropagation, micrografting and meristem culture. Nursery registration act. Management of insect-pests and diseases in nursery. Cost of establishment of a modern nursery.

Practical

Selection of site, soil sterilization and preparation of beds for nursery raising. Preparation of growing media and use of different nursery containers for containerized nursery production in fruits and plantation crops. Seed treatments for breaking dormancy and prevention of nursery diseases. Sowing of seed, raising and maintenance of rootstock/ seedlings. Practicing different vegetative propagation methods, viz. cutting, layering, grafting and budding. Preparation of plant growth regulators for seed germination and

vegetative propagation. Digging, labelling and packing of field grown nursery plants. Familiarization with propagation structures mist chamber, greenhouse, glasshouse, polyhouse and net house; and their maintenance. Micropropagation and hardening of plants. Tissue culture media preparation, explant preparation, in vitro culturing and shoot tip culture, primary and secondary hardening of tissue culture plants. Maintenance of nursery records. Identification and management of insect-pests and diseases in nursery. Project formulation for small and high-tech nurseries. Nursery Accreditation.

Suggested readings

1. Davies F T Geneve R L and Wilson S B 2018. Hartmann and Kester's Plant Propagation
2. Principles and Practices 9th edn. Pearson. USA.
3. ICAR 2019. Handbook of Horticulture 2nd edition ICAR Vol 1 and 2. New Delhi.
4. Peter K V 2002. Plantation crops. National Book Trust India, New Delhi.
5. Sharma R R and Krishna Hare 2017. Textbook of Plant Propagation and Nursery Management.C B S Publishers. New Delhi.
6. Sharma R R and Srivastava Manish 2004. Plant Propagation and Nursery Management. IBDC Publishers. New Delhi

HORT 107 COMMERCIAL PRODUCTION OF FLOWER CROPS 3(1+2)

Objectives

Imparting knowledge about climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, nutritional and irrigation requirements, intercultural operations, weed management, physiological disorders, postharvest management, plant protection measures of major flower crops.

Theory

Scope and importance of flower cultivation. Soil, climate, varieties, propagation, special intercultural operations, fertilizers requirement, irrigation, use of growth regulators, weed management, plant protection measures, harvesting, grading, packaging, and storage of rose, jasmine, carnation, chrysanthemum, gladiolus, marigold, tuberose and cut foliage crops under open/partial shade. Seed production of flowering annuals.

Practical

Introduction of flower crops. Identification of commercial varieties, propagation techniques, bed preparation, soil decontamination, planting and layout, training, pruning, staking, growing media, potting and repotting. Containers for growing flowers for exhibition. Fertilizer calculations and application, growth regulator application. Weed management and plant protection measures. Special horticultural practices in cut flower and cut foliage crops. Determination of harvest indices, harvesting methods and postharvest handling. Commercial Standards, Packing methods. Project preparation. Visit to commercial flower market and progressive growers having high-tech farms.

Suggested readings

1. Arora JS. Introductory Ornamental Horticulture.

2. Aswath C, Bose TK, Dutta K, Reeta Bhatia and Saha TN Commercial Flowers Vol. 2.
3. Bose TK, Maiti RG, Dhua RS, Das P. Floriculture and Landscaping (Vol.1).
4. Purohit S S and Bhardwaj Prasad R L A 2016. Textbook of Production Technology of Vegetable and Flower Crops Agrobios (India); 400 p.
5. Randhawa, G. S. and Mukhopadhyay Amitabha 1986. Floriculture in India, Allied Publishers, - 660 p.
6. Singh A K 2006. Flower Crops: Cultivation and Management, New India Publishing,Gardening- 480 p.
7. Vishnu Swarup 1967. Garden Flowers: Buy Garden Flowers, National Book Trust, India, 261p.

HORT 108 SPRINKLER & MICRO IRRIGATION SYSTEMS 2(1+1)

Objectives

To acquaint the students with the basic knowledge of modern irrigation systems

Theory

Sprinkler irrigation: adaptability, types, problems and prospects. Sprinkler/micro sprinkler irrigation system design: steps, layout, selection, design of lateral, sub-main and main pipeline, selection of pump and power unit. Performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency. Micro irrigation system: types, merits and demerits, components. Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection, hydraulics and design steps. Steps for proper operation of a drip irrigation system. Maintenance of micro irrigation system: clogging, filter cleaning, flushing and chemical treatment. Fertigation: advantages, limitations, methods, fertilizers solubility and their compatibility, precautions, frequency, duration and injection rate. Economics: Cost estimation of sprinkler and micro irrigation system. Basic principles of soil-plant-water analysis; Method of fertilizer application, Fertigation: advantages, limitations, methods, fertilizer solubility and their compatibility, precautions, frequency, duration and injection rate.

Practical

Study of different components, design and installation of sprinkler irrigation system. Determination of precipitation pattern, discharge and uniformity coefficient. Study of different components, design and installation of drip irrigation system. Determination of pressure discharge relationship and emission uniformity for emitter. Study of different types of filters and determination of filtration efficiency. Determination of rate of injection and calibration for chemigation / fertigation. Design of irrigation and fertigation schedule for crops. Field visit to micro irrigation system and evaluation of drip system. Cost economics of sprinkler and drip irrigation system. Soil, plant and water sampling and processing in horticultural crops, estimation of pH, organic C and available N, P, K in soil; determination of rate of injection and calibration for fertigation. Design of irrigation and fertigation schedule for crops.

Suggested readings

1. Biswas, R.K. 2015. Drip and Sprinkler Irrigation. New India Publishing Agency.

2. Goyal, M.R. 2016. Micro Irrigation Management Technological Advances and Their Applications - Innovations and Challenges in Micro Irrigation. CRC Press.
3. James, L.G. 1993. Principles of Farm Irrigation System Design. Krieger publishing Company, Malabar, Florida.
4. Mane, M.S. and Ayare, B. L. 2019. Principles of Sprinkler Irrigation. Jain Brothers, N. Delhi,4th edn.
5. Mane M.S and Ayare, B. L. 2019. Principles of Drip Irrigation. Jain Brothers, New Delhi.

SEC (I)-109 VERMICOMPOST PRODUCTION 2(0+2)

Practical

Introduction of vermiculture, Waste materials : Classification, disposal techniques, their segregation and processing, Bed preparation for anaerobic and aerobic composting and mixing of beds ,Earthworm collection, identification and application on beds, vermicompost collection, earthworm separation, Air drying of vermicomposting, sieving and storing, vermi-wash production technique, collection and processing, Study of vermi disease and enemies and their control, Nutritional composition of vermicompost for plants. technique of composting in a limited space, scope of vermicomposting as entrepreneurship.

SEC(I)-110 PRODUCTION OF ORNAMENTAL FISH & AQUARIUM PLANTS 2(0+2)

Practical

Morphological and Anatomical Study of Ornamental Fish Species: (i) Identification of different types of ornamental fishes with special reference to morphological features. (ii) Anatomy of different types of ornamental fishes with special reference to breeding habits and behaviour.

Breeding and Rearing of Ornamental Fishes: (i) Demonstration of the setting up of infrastructures, facilities and methods for breeding of different types of ornamental fishes. (ii) Demonstration of rearing methods and management of different types of ornamental fish seed.

Fabrication, Setting up and Management of Freshwater Aquarium: (i) Demonstration of the fabrication of aquariums. (ii) Demonstration of setting up and decoration of different types of aquaria, (iii) Management of different types of functional aquaria.

Mass Culture of Live Food Organisms for Ornamental Fish Rearing: (i) Identification of different types of live-food organisms. (ii) Culture and production of different types of live food organisms.

Propagation of Aquarium Plants: (i) Identification of different types of aquarium plants. (ii) Propagation of different types of aquarium plants. Live Fish Transportation: (i) Demonstration of different methods for transportation of live fish.

SEC(II)-111 MUSHROOM PRODUCTION 2(0+2)

Practical

Scope and importance of mushroom cultivation. Morphology and types of mushrooms. Isolation, purification and transfer of mushroom fungus on new culture medium for

sub-culturing. Facilities required for spawn production. Techniques of spawn production. Structure of a commercial mushroom growing unit. Cultivation methods and economics of mushrooms cultivation. Post- harvest handling, and marketing of mushrooms. Diseases and pests of mushrooms and their management.

SEC(II)-112 SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS 2(0+2)

Practical

Vegetable seed industry in India, Floral biology, pollination and breeding behaviour of important vegetable crops, Categories of seeds and their maintenance, Characteristics of quality seed, Agronomical principles and methods of seed production in important vegetable crops, Use of growth regulators and chemicals in vegetable seed production, Methods of hybrid seed production, Seed harvesting, extraction, curing, drying, grading, packaging and storage, Seed sampling and seed testing (genetic purity, seed viability, seedling vigour, germination, physical purity), Visit to seed processing units, seed testing laboratory and seed production farms.

SEMESTER II

CC-151 FARMING BASED LIVELIHOOD SYSTEMS 3 (2+1)

Objectives

1. To make the students aware about farming based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban & rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS) : Meaning, approach, approaches and framework , Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional & modern farming systems. Components of farming system/ farming based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk & success factors in farming based livelihood systems, Schemes & programmes by Central & State Government, Public & Private organizations involved in promotion of farming based livelihood opportunities. Role of farming based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization & changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of components of important farming based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises & their functional aspects for integration of production, processing & distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming based livelihood systems along with cost & profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7.
2. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India
3. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
4. Dixon, J. and A. Gulliver with D. Gibbon. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & World Bank, Rome, Italy & Washington, DC, USA Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
5. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar,
6. P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram. Walia, S. S. and Walia, U. S. 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

CC-152 PERSONALITY DEVELOPMENT 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality Definition, Nature of personality, theories of personality and its types. Determinants of personality, Tips to improve personality, Locus of control and performance, Type A and Type B behaviours. Foundations of individual behavior and factors influencing individual behavior, Perception and attributes and factors affecting perception, Attribution theory. Learning: Meaning and definition, theories and principles of learning, Learning and training. Attitude and values. Intelligence-concept, definition types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, emotional intelligence. Motivation- concepts, socio psychological needs; theories of motivation Teamwork and group dynamics.

Practical

MBTI personality analysis, Motivational needs, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles.

Suggested Readings

1. Mondal Sagar 2017. Textbook of Rural Sociology and Educational Psychology
2. Mondal Sagar 2018. Communication Skills and Personality Development, Kalyani Publishers, Ludhiana Kumar, Pravesh. 2005. All about Self- Motivation. New Delhi. Goodwill Publishing House Smith, B. 2004. Body Language. Delhi: Rohan Book Company.
3. Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadswor

CC-153 NATIONAL SERVICE SCHEME (NSS)-II 1 (0+1)

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, an misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

AGR-154 INTRODUCTION TO MAJOR FIELD CROPS 3 (2+1)

Objectives

1. To provide in-depth understanding about crop response to variable agronomic factors

2. To inculcate the skill of raising field crops with appropriate agronomic practices for higher productivity

Theory

Classification and distribution of field crops, definition, concept and principles of multiple cropping, mixed cropping, intercropping, relay and alley cropping, crop rotation. Economic importance, soil and climatic requirement, varieties, cultural practices for raising major cereals (rice, wheat, maize), pulses (gram, lentil, arhar, mungbean), oilseeds (rapeseed and mustard, groundnut, sesame, soyabean), cash crops (cotton, sugarcane) and fodder crops (sorghum, *bajra*, berseem, oats). Principles and practices of green manuring.

Practical

Identification of crop plants, seeds, weeds. Preparation of cropping scheme. Method of sowing, fertilizer and herbicide application in field crops. Calculation of fertilizer and herbicide dose.

Suggested readings

1. Anonymous, 2023, Package of practices for *kharif* crops.
2. Anonymous, 2023, Package of practices for *rabi* crops.
3. Reddy T Y and Reddy G H S, 2020, Principles of Agronomy, Kalyani Publishers, Ludhiana.
4. Singh Chidda, 2020, Modern techniques of raising field crops. Oxford and IBH Publication.

HORT-155 COMMERCIAL PRODUCTION OF SPICES AND PLANTATION CROPS 3 (1+2)

Objectives

To inculcate the skill of raising spices and plantation crops with appropriate agronomic practices for higher productivity

Theory

Present status and importance of spice crops, soil and climate requirements, commercial varieties, site selection, layout, sowing time and methods, nutritional and irrigation requirements, intercropping, weed control, physiological disorders, harvesting, post-harvest management and
plant protection measures of the following crops: Black pepper, turmeric, ginger, garlic, clove, cinnamon, fenugreek, cumin, ajowain, coriander, fennel, cardamom, Vanilla, betelvine and celery. Area, production and export potential of plantation crops, varietal wealth, cultivation systems, multitier cropping, high density planting, nutritional and irrigation requirements, weed management, training and pruning, physiological disorders, maturity indices, harvesting, postharvest management and plant protection measures of the following crops: Coffee, tea, cashew, rubber, coconut, arecanut, cocoa and oil palm.

Practical

Identification of seeds and plants, propagation, nursery raising, field layout, planting methods, cultural practices, harvesting and handling, visit to fields and marketing centres.

Suggested readings

1. Kumar N 2018. Introduction to spices plantation crops medicinal and aromatic plants. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
2. Peter K V 2002. Plantation crops. National Book Trust India, New Delhi.
3. Pruthi J S 1998. Major Spices of India Crop Management and Post Harvest Technology ICAR. Krishi Anusandhan Bhavan, Pusa, New Delhi.

HORT-156 PLANT PROPAGATION AND NURSERY MANAGEMENT IN VEGETABLE, FLOWER AND MEDICINAL CROPS 3 (1+2)

Objectives

1. Study of biology and types of propagation, tissue culture and physiology of seed, seed storage and dormancy
2. Knowledge of nursery management, nursery establishment and nursery techniques for plant propagation
3. Propagation from specialized structures in major vegetable, flower crops, medicinal and aromatic plants

Theory

Nursery management practices for vegetables, flowers and medicinal crops, Biology of plant propagation, Sexual and Asexual plant propagation, physiology of seed, seed storage and dormancy, physiology of cutting, layering, grafting, budding. Tissue culture, Maintenance of elite germplasm and mother stock. Propagation from specialized modified plant parts, crop specific plant propagation practices in commercial vegetables and flowers. Nursery techniques and crop specific propagation methods of medicinal crops.

Practical

Identification of planting material, commercial varieties of vegetable, flowers and medicinal crops. Propagation and multiplication, seed production. Potting, repotting and maintenance of houseplants. Practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking. Harvesting techniques. Crop-specific plant propagation practices. Visit to local nurseries and florist centers. Marketing requirements and strategies for sale of important crops.

Suggested readings

1. Plant Propagation: Principles and Practices by Hartmann and Kester
2. Plant Propagation and Nursery Management by Tarai Ranjan Kumar

SEC (III) 161 SOIL, PLANT AND WATER ANALYSIS 2(0+2)

Practical

Basic idea for establishment of a soil, water and plant testing laboratory. Determination of pH, EC, organic carbon, sulphur, macro and micronutrient elements in soil. Irrigation water quality analysis. Determination of pH, EC, carbonates and bicarbonates, calcium and magnesium, sodium, potassium, chlorine and boron in irrigation water. Estimation of macro and micromutrient elements in plant samples. Rapid tissue test for soil and plant analysis. Interpretation and recommendation of the results obtained after soil, water and plant testing.

SEC (III) 162 BEEKEEPING 2(0+2)

Practical

Acquaintance with bee keeping equipments and handling of bees, Artificial queen rearing, Multiplication of bee colony, Management of bees during different seasons, Extraction of honey and bee wax, Ripening of honey and its quality control, Production of royal jelly, Management of insect and mites of bees, Management of insect and mites of bees.

SEC (III) 163 ORCHARD FLOOR MANAGEMENT 2(0+2)

Practical

Layout of different systems of orchards and Fruit Nutrition Garden. Soil management practices: clean cultivation, sod culture, sod mulch, intercropping, cover cropping and mixed cropping. Use of mulch materials: organic and inorganic, moisture conservation and weed control. Layout of various irrigation systems, surface irrigation: Flood system, basin system, modified basin system, furrow method, sub-surface irrigation systems: drip irrigation and its components, overhead irrigation: sprinkler system, fertigation, Different methods of application of manure and fertilizers, use of organic manures, Biofertilizers, Green manuring and bio-agents. Visit to orchards of Progressive fruit growers.

SEC (IV) 164 AGRO FORESTRY MANAGEMENT 2(0+2)

Practical

Agroforestry definitions, objectives, potential and distinction between agroforestry and forestry Introduction of different types of Agroforestry: A) Agri-silviculture, B) Agri-Horticulture, C) Agr-Horti-Silviculture, D) Agri- silvi-pasture, Visit to the different agroforestry types Nursery bed preparation for forest species, Nursery bed preparation for Horticultural crops, Method of planting/sowing Agroforestry with field crop and vegetable crops. Method of planting/sowing Agroforestry with fruit crops, Tree growth measurement and estimation of tree log/forest biomass, Estimation of yield of different field and fruit crops, Techno-economical feasibility of the three popular agroforestry types (Agri-silviculture, Agri-Horticulture, Agri-Horti-Silviculture).

SEC (IV) 165 ORGANIC PRODUCTION TECHONOLOGY 2(0+2)

Practical

Preparation of a pre-designed programme plan for establishing organic farm, Selection and treatment of seeds and planting materials in organic system, Nutrient management through organic inputs , Water management and interculture operation, Weed, pest and disease management in organic system of cropping, Harvesting, storing, packaging and labeling, Organic certification process , Growing various crops with organic package of practices and visit to certified organic farm and Grower group of farmers.

SEC (IV) 166 NURSERY PRODUCTION OF HORTICULTURAL CROPS 2(0+2)

Practical

Layout of model nursery, Tools and equipment-identification and application. Different methods of breaking seed dormancy stratification, scarification and use of plant growth regulators Extraction and storage of healthy seeds, seed bed preparation, Identification and raising of rootstocks for different fruit plants, soil solarization, preparation of potting mixtures. Selection of healthy scion wood, practices in different methods of plant propagation like cutting, layering, budding and grafting in fruit plants. Micropropagation-explant preparation, media preparation, culturing–meristem tip culture, axillary bud culture, micro-grafting and hardening of plants. Nursery management practices i.e. weed control, irrigation, nutrition, removal of sprouts etc. Protection of nursery plants against adverse climatic conditions. Protected structures. Diagnosis and control of important diseases and pests in the nursery, lifting and packing of nursery plants, Visit to commercial tissue culture laboratories and accredited nurseries

SEMESTER III

CC–201 PHYSICAL EDUCATION, FIRST AID, YOGA PRACTICES AND MEDITATION 2(0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality

development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yog, Types of Yog, Introduction to Yog,

- Asanas (Definition and Importance) Padmasan,san, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra,Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics Need and requirement of first aid. First Aid equipment and upkeep. First aid Techniques, First aid related with Respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons.Sports injuries and their treatments.

ACSS(H) 202 FUNDAMENTALS OF SOIL SCIENCE 3(2+1)

Objectives

To make the students aware about the importance of soil in relation to soil formation, texture, structure, water, temperature, aeration, nutrient availability, and soil microbiology, soil survey

Theory

Composition of earth's crust, soil as a natural body – major components. Eluviation, Illuviation formation of various soils. Physical parameters; texture – definition, methods of textural analysis, stock's law, assumption, limitations, textural classes, use of textural triangle; absolute specific gravity/ particle density, definition, apparent specific gravity/bulk density – factors influencing, field bulk density. Relation between BD (bulk density), AD – practical problems. Pore space – definition, factors affecting

capillary and non-capillary porosity, soil colour – definition, its significance, colour variable, value hue and chroma. Munsell colour chart, factors influencing, parent material, soil moisture, organic matter, soil structure, definition, classification, clay prism like structure, factors influencing genesis of soil structure, soil consistency, plasticity, Atterberg's constants. Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal, soil temperature, sources and distribution of heat, factors influencing, measurement, chemical properties, soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion importance, soil water, forms, hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale, measurement, gravimetric – electric and tensiometer methods – pressure plate and pressure membrane apparatus–Neutronprobe–soil water movement–classification– aerial photography– satellite of soil features – their interpretation; soil orders; land capability classification; soil of different eco-systems and their properties, Rock and Minerals classification, Pedogenic process. Objectives of soil science research institute in India (NBSS and LUP, ISSS, LTFE and NSSTL). Management of Soil Crusting, Soil Compaction and Soil Compression. Soil Biology benefits and harmful effects. Methods and objective of soil survey, Remote sensing application in soil and plant Studies, Soil degradation.

Practical

Collection and preparation of soil samples, estimation of moisture, EC, pH and bulk density. Textural analysis of soil by Robinson's pipette method. Description of soil profile in the field. Quantification of minerals and their abundance. Determination of Soil colour using Munsell Chart. Estimation of water holding capacity and hydraulic conductivity of soils. Estimation of Infiltration rate using double ring infiltrometer method. Estimation of soil moisture using gypsum block and neutron probe method. Soil compaction measurement with Pentrometer. Determination of pore space of soil. Determination of field capacity and permanent wilting point of soil. Determination of soil water potential characteristic curves by tensiometer and pressure plate apparatus. Aggregate size distribution analysis of soil. Air capacity of soil by field meth Nursery raising/procurement and transplanting, management and maintenance of the crop, postharvest handling, quality control and marketing.

Suggested readings

1. Das D K. 2011. Introductory Soil Science Third Revised Edition Kalyani Publishers. Ludhiana.
2. Fundamentals of Soil Science by Indian Society of Soil Science Second Revised Edition 2009. Indian Society of Soil Science. New Delhi.
3. Nyle C Brady and Weil Ray R. 2016. The Nature and Properties of Soils 15th Edition. Prentice Hall of India Pvt Ltd. New Delhi.
4. Sharma Pradeep K. 2017. Introduction to Soil Physics First Edition Westville Publishing House. New Delhi.
5. Saha A K. 2008. Text Book of Soil Physics Reprinted. Kalyani Publishers. Ludhiana.
6. Sehgal J A. 2005. Textbook of Paedology Concepts and Applications Kalyani Publishers. Ludhiana.

HORT – 203 URBAN AND PERI URBAN HORTICULTURE 2(1+1)

Objectives

1. To acquaint the students about the unban and peri-urban horticulture and its types.
2. To impart the knowledge about the cultivation practices of horticultural crops in urban and peri-urban areas.

Theory

Introduction to urban and peri-urban horticulture: Definition, importance, characteristics and scope. Types of urban and peri-urban gardens and their characteristics: Terrace gardening, vegetable gardening, container gardening, rooftop gardens, community gardens, vertical gardens, hydroponics and aeroponics. Selection of site, planting material, media (soil and soilless) preparation and nutrient management for cultivation of vegetables, herbs, fruits, flowers and ornamental plants. Protected cultivation in urban and peri-urban areas. Making and maintenance of lawns. Interior and exterior landscaping in urban and peri-urban households. Water and waste management, waste water recycling and its use in landscaping. Insect-pest and disease management in urban horticulture.

Practical

Site selection and layout of various urban and peri-urban gardens. Preparation of growing media and potting mixtures. Types of containers, nursery raising and planting for rooftop gardens.Irrigation and nutritional management in urban and peri-urban horticulture. Visit to fruit nutrition garden, vegetable kitchen garden and public gardens.

Suggested readings

1. Alka Singh, Patel NL and Ahlawat TR 2016. Handbook of Urban and Periurban Horticulture; Publisher: Ambica; 1st edn.
2. Sumangla HP, Malhotra S K and Chowdappa P 2013. Urban and peri-urban horticulture- A perspective.

HORT–204 PRECISION FARMING AND PROTECTED CULTIVATION 3(2+1)

Objectives

The students will learn about the basics of cultivation of plants under protected conditions

Theory

Precision farming – laser levelling, mechanized direct seed sowing; seedling and sapling transplanting, site specific input application. Protected cultivation technology: Introduction, techniques of protected cultivation, types of Green Houses, Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Green house equipment, materials of construction for traditional and low-cost green houses. Irrigation systems

used in protected cultivation, Typical applications, passive solar green house, hot air greenhouse heating systems, greenhouse drying. Cost estimation and economic analysis. Choice of crops for cultivation under protected structures, problems/constraints of greenhouse cultivation and future strategies. Growing media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT)/ hydroponics.

Practical

Laser levelling procedure and field visit. Study and field visit for mechanized direct seed sowing and transplanting. Study of different types of greenhouses based on shape, construction and cladding materials. Studies on different environment control parameters in greenhouses. Estimation of drying rate of agricultural products inside greenhouse. Testing of soil and water to study its suitability for growing crops in protected structures. The study of fertigation requirements for greenhouse crops and estimation of E.C and pH in the fertigation solution. The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization/sterilization. Visit to commercial protected cultivation structures. Economics of protected cultivation.

Suggested readings

1. Brahma S 2019. Precision Farming and Protected Cultivation. NIPA, New Delhi.
2. Michael A M 2008. Irrigation Theory and Practices. Vikas Publishing House Pvt. Ltd., New Delhi.
3. Kumar S 2002. Precision Farming and Protected Cultivation: Concepts and Applications. Narendra Publishing House, New Delhi.

HORT –205 SEED PRODUCTION OF VEGETABLE, TUBER AND SPICE CROPS 3(2+1)

Objectives

1. Students will acquire skill for certification and storage of seed production of vegetable, tuber and spice crops
2. Students will be trained for on-farm operations of different seed multiplication activities of vegetable, tuber and spice crops.

Theory

Introduction and history of seed industry in India. Definition of seed, classes-types of seed. Differences between grain and seed. Importance and scope of vegetable seed production in India.

Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production, land requirements, climate, season, planting time, nursery management, seed rate, rouging, seed extraction and storage, packaging and labelling of cole crops, root vegetables, solanaceous vegetables, cucurbits, okra, leafy vegetables, bulb crops, tuber crops like potato, spice crops like coriander, fenugreek, leguminous vegetables and exotic vegetables. Seed germination and purity analysis. seed priming and pelleting, Field and seed standards. Seed drying and extraction. Seed legislation.

Practical

Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production, Seed certification in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, okra, leafy vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units

Suggested readings

1. Arya Singh P. 2003. Vegetable seed Production Principles. Kalyani Publishers. Ludhiana.
2. Hazra P and Som M G. 2009. Vegetable seed production and Hybrid Technology. Kalyani Publishers, Ludhiana.
3. Kulkarni G N. 2002. Principles of Seed Technology. Kalyani Publishers, Ludhiana.
4. Ram HH, Upadhyay R, Dubey R K and Mandal B C. 2017. Vegetable seed production-Principles and practices. Kalyani Publishers, Ludhiana.
5. Singh, S P. 2001. Seed production of commercial vegetables. Agrotech Publishing, Udaipur

HORT –206 Farm Power and Machinery for Horticulture - 3 (2+1)

Objectives

To acquaint students of the tools available at his disposal for doing the work in horticulture (mechanical power source: engines tractors, machines and tools for harvesting the horticultural produce tillage equipment, planting equipment, plant care equipment)

Theory

Basic concepts of various forms of energy. Tractors, power tillers and their types and uses Introduction about IC Engines Bass principles of operation of compression, ignition and spark ignition engines, two stroke and four stroke engines; Crank system, valve system, fuel supply system, cooling and lubrication systems; power transmission systems; broad understanding of performance and efficiency. Tillage: objectives, method of ploughing construction and function of improved indigenous ploughs, mould board ploughs, disc and rotary ploughs, cultivators, harrows, levellers, ridgers and bund formers. Post-hole digger. Introduction about planting and transplanting equipment potato planters, small seed planter, nursery sowing machinery, vegetable transplanters. Introduction about intercultural machinery. Sweep, rotary weeders. Crop harvesting equipment potato diggers, fruit-pluckers.

Practical

Calculation on force, power and energy. IC engines-showing the components of dismantled engines Familiarization with engine systems Primary and secondary tillage implements hitching. Adjustments and operations. Operation of post hole digger. Operation of planting and transplanting machinery. Operation of vegetable transplanters, plastic match and drip laying machinery. Operation of crop harvesting

equipment and seed extraction machine. Operation of shrub cutters, fruit-pluckers, pack positioner.

Suggested readings

1. Michael A M and Ojha T P. Principles of Agricultural Engineering.
2. Sahay Jagdishwar. Elements of Agricultural Engineering.
3. Kepner R A. Bainer R and Barger E L. Principles of Farm Machinery.

PPA(H) 207 DISEASE MANAGEMENT OF HORTICULTURE CROPS 3(2+1)

Objectives

1. To identify various pathogen structures and diagnose the diseases of horticultural crops in field
2. To understand the disease cycle and epidemiology of various diseases of horticultural crops
3. To give an overview of various disease management methods (cultural, physical biological, chemical)

Theory

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases under protected conditions and of fruits, plantation, medicinal, aromatic, vegetables, ornamental, and spice crops *viz.* mango, litchi, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, tomato, brinjal, chilli, bhindi, cabbage, cauliflower, radish, knol-khol, pea, beans, beet root, onion, garlic, fenugreek, ginger, potato, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine, senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum*, Tephrosia, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon, jasmine, rose, crossed, tuberose, gerbera, anthurium, geranium, marigold, gladiolus. Important post-harvest diseases of fruit, plantation, medicinal, aromatic, vegetables, ornamental and spice crops and their management. Etiology, symptoms and integrated management of important plant parasitic nematodes of fruits – (tropical, sub-tropical and temperate) vegetables, tuber, ornamental, spice and plantation crops. Role of nematodes in plant disease complex.

Practical

Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases of fruits, plantation, medicinal, aromatic, vegetables, ornamental and spice crops. Collection and preservation of diseased plant specimen

Suggested readings

1. Gupta S K and Thind T S 2018. Disease problems in Vegetable Production. Scientific Publishers India, P.586.
2. Gupta S K Sharma R C and Sharma M 2017. Diseases of Vegetable. Ornamental and Spice crops. Scientific Publishers India.
3. Mehrotra R S and Aggarwal A 2003. Plant Pathology. 2nd edn. Tata Mc Graw Hill Publication Com Ltd, P.846.

4. Pathak V N 1989. Diseases of fruit crops. Oxford and IBH Publication Comp. New Delhi, P.309.
5. Rangaswami G and Mahadevan A 2002. Diseases of crop plants in India 4th Edition. Prentice Hall of India Pvt. Ltd. New Delhi, P.536.
6. Singh R S 1987. Diseases of vegetable crops 2nd Edition. Oxford and IBH Publication. Comp New Delhi, P. 362.
7. Singh R S 2018. Plant Diseases 10th edn. Oxford and IBH Publication.New Delhi,P.821.
8. Singh R S 2018. Diseases of fruit crops 2nd edn. Med Tech. New Delhi, P.281

SEC (V) – 211 PRODUCTION TECHNOLOGY OF BIO-AGENTS 2(0+2)

Practical

Introduction to biological control. Types of biocontrol agents.Facilities required in general for mass production of natural enemies and biopesticides. Mass rearing of fictitious host insects of biocontrol agents on natural or artificial diets.

a) Corcyra cephalonica, b) *Spodopteralitura*, c) *Helicoverpaarmigera*, d) Mealy bugs, e) *Galleria mellonella*.

Mass production of biocontrol agents (Any two groups)

A. Mass production of predatory and parasitic group of insect: a) *Trichogramma chilonis / T. japonicum*, b) *Bracon brevicornis c) Telenomu s*sp. *d*) *Chrysoperla carnea* or Mallda sp. e) *Cheilomenessex maculata* or *Scymnus* (*Pullus*) *posticalis*or *Serangium parcesetosum*, f) *Rhynocoris marginata g) Blaptostethus pallescens* or *Oriu s*sp.

B. Mass production of weed feeding insect herbivore – *Zygogranma bicolorata.*

C. Mass production of entomo pathogenic nematode –*Heterorhabditi s*sp. or *Steinernema* sp.

D. Mass production of HaNPV or SlNPV

Quality assurance, field release or application. Economics involved in commercial production - Benefit Cost Ratio.

SEC (V) - 212 PRODUCTION OF BOTANICAL PESTICIDES 2(0+2)

Objective

Skill development for Bio-Pesticide Production for eco-friendly crop protection

Practical

Introduction, Types of bio-pesticides, Bio-pesticide market, Botanicals as bio-pesticides; Principle & techniques of extraction of bio-active constituents from plants (Selection and collection of plants, drying and grinding, solvent extraction and evaporation); Basic principle and techniques of solid (WP) and liquid (EC) formulation production (Carriers, diluents, solvents & surfactant selection and optimization); Formulation and packaging of solid (WP) and liquid (EC) formulations; Quality assurance of WP/EC formulations (pH range; Emulsion Stability and re-emulsification; Wet Sieve Test; Suspensibility; Persistent Foam; Wettability, Accelerated Storage Stability, etc.); Economics involved in commercial production; Benefit cost ratio; Registration of botanical pesticides; Marketing strategy: product promotion and sale.

Suggested Readings

1. Leo ML, Nollet and Rathore HS. 2017. Green Pesticides Handbook: Essential Oils for Pest Control (ISBN-13: 978-1498759380), CRC Press, pp 570.
2. Parmar BS and Devakumar C. 1990. Botanical and Biopesticides. Westvill Publ. House
3. Teicher HB. 2017. Pesticides and Biopesticides: Formulation and Mode of Action (Publisher: BioComm Press), pp 166.
4. Valkenburg WV. 2008. Pesticide Formulation: Recent Developments and Their Applications in Developing Countries (ISBN-13: 978-8122410693), New Age International (P) Limited, Publishers; First edition (2008) pp 488.

SEC (V) – 213 POST HARVEST MANAGEMENT OF HORTICULTURAL CROPS 2(0+2)

Practical

Layout and planning of postharvest experiments, Maturity and harvesting of horticulture produce. Judging maturity by different methods. Harvesting tools. Objective measurement of colour, texture and dry matter. Components and equipment used in Postharvest laboratory, Different types of cleaning agents and washing methods for horticultural produce. Layout of pack house and General pack house operation. Sorting, surface sanitizing and drying of fruit. Postharvest treatments for shelf life extension of fruits and vegetables. Packing of fruits in different packaging materials, preparation of different coating materials and their method of applications. Pre-cooling of horticultural produce. Ripening technology for horticultural crops. Significance of sorting and grading in horticulture produce: Types of grading system and standards. Cold-chain management. Storage requirements. Commercial technologies for processing of horticultural produce.

SEC (V) – 214 SEED PRODUCTION AND PROCESSING TECHNOLOGY 2(0+2)

Objectives

Development of students' skill in crop seed production

Practical

Field visit during seed production in the farm; Receiving of harvested farm seeds considering different steps; Seed drying techniques; Pre-cleaning, Fine cleaning of seeds, Grading; Seed sampling and seed quality analysis through different tests; Seed treatment practices considering different types (like pesticide, insecticide and fungicides); Types of seed packaging materials, appropriate quantity of seed, Storage of Seed Visit Seed processing plant and layout.

SEC (V) – 215 MOLECULAR DATA ANALYTICS 2(0+2)

Objectives

To help the student to achieve soft skill for handling biological data and its analysis

Practical

Collection of data , Tabular representation of data, Graphical representation of data, Use of MS- Excel for data analysis, Preparation of binary data after Gel electrophoresis, DNA Marker parameter analysis with binary data using MS-Excel, Cluster Analysis using binary data, Biological Database Searching: NCBI, PDB, Database Similarity Searching: BLAST, Pair wise Sequence Alignment tools: EMBOSS, Multiple Sequence Alignment tool: Clustal Omega, Tools for DNA Sequence analysis, Tools for Protein sequence analysis, Visualization tools for Protein 3D structure

Suggested Readings

1. Attwood, T.K. and Parry-Smith, D.J. 2004.Introduction to Bioinformatics, Pearson Education (Singapore) Pvt. Ltd.
2. David Edwards (Ed.) 2007. Plant Bioinformatics: Methods and Protocols. Humana Press, New Jersey, USA.
3. XiongJ.2012. Essential Bioinformatics, Cambridge University Press.
4. Ewens W.J and Grant G.R. 2001. Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology and Health). Springer.
5. Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice.
6. John Wiley. Panse VG and Sukhatme PV. 1983. Statistical Methods for Agricultural Workers, ICAR.
7. Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.

SEMESTER IV

CC –251 AGRICULTURAL INFORMATICS AND ARTIFICIAL INTELLIGENCE 3(2+1)

Objective

1. To acquaint student with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in Agriculture
3. To make students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating data base, Uses of DBMS in Agriculture. Internet and World Wide Web (WWW): Concepts and components. Computer programming: General concepts, Introduction general programming concepts. Concepts and standard input/output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture. Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, inputs-outputs files, limitation, advantages and application of

models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management. Smartphone mobile apps in agriculture for farm advice: Market price, post-harvest management etc. Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information. Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System, Soil Information Systems etc., for supporting farm decisions. Preparation of contingent crop planning and crop calendars using IT tools. Digital India and schemes to promote digitalization of agriculture in India. Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A*algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/Linux, creating files and folders, File Management .Use of MS-Word and MS Power-point for creating, editing and presenting a scientific documents, MS-EXCEL-Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smartphones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial technology, AR/ VR demonstration, Preparatio of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India. Fundamentals of Computer by V. Rajaroman.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C. J. Date.
4. Introductory Agri-Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

CC–252 ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS COMMUNICATION 3 (2+1)

Objective

1. To provide student an insight into the concept and scope of entrepreneurship

2. To expose the student to various aspects of establishment and management of a small business unit
3. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning: spotting of opportunity, scanning of environment identification of product / service: starting a project; factors influencing sensing the opportunities. Infrastructure and support systems: good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management: product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management: raw material costing, inventory control. Personal management: manpower planning, labour turn over, wages / salaries. Financial management /accounting: funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management: market, types, marketing assistance, market strategies. Crisis management: raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agri centrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath, P.M. 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai, V. 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
3. Gupta, C.B. 2001. Management Theory and Practice. Sultan Chand & Sons.
4. Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Khanka, S.S. 1999. Entrepreneurial Development. S. Chand & Co.
6. Mehra, P. 2016, Business Communication for Managers. Pearson India, New Delhi.
7. Pandey, M. and Tewari, D. 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
8. Singh, D. 1995. Effective Managerial Leadership. Deep & Deep Publ.
9. Singhal, R.K. 2013, Entrepreneurship Development & Management, Katson Books.

10. Tripathi, P.C. and Reddy, P.N. 1991. Principles of Management. Tata McGraw Hill.
11. Vasant Desai, 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House.

HORT – 253 COMMERCIAL VEGETABLE PRODUCTION 4(3+1)

Objectives

Student shall gain expertise on commercial cultivation of vegetable crops

Theory

Importance of Olericulture. Vegetable gardens. Vegetable classification, area, production and varieties. Package of practices of tomato, brinjal, chillies, capsicum, moringa and okra. Cucurbitaceous vegetables- cucumber, ridge gourd, ash gourd, snake gourd, bottle gourd, bitter gourd, pumpkin and melons. Cole crops - cabbage, cauliflower, broccoli, Chinese cabbage, Brissels sprouts and knolkhol. Bulb crops - onion and garlic. Beans and peas - French beans, cluster beans, dolichos beans, peas and cowpea. Tuber crops - potato, sweet potato, tapioca, colocasia, yams. Root crops - carrot, radish, turnip and beet root. Leafy vegetables – lettuce, spinach, spinach-beet, Amaranthus (Note sag, lal sag), Basella (Poi) and Ipomea (kolmi).

Practical

Identification of vegetable crops and seeds; Planning, layout and maintenance of kitchen garden; Direct sowing of vegetables, Bed preparation and method of nursery sowing; Transplanting of vegetable seedlings; Method of fertilizer application and calculation of different fertilizer doses; Intercultural operations in vegetable crops, Harvesting, grading and packaging of vegetable crops, Economics of vegetable crops, Visit to commercial vegetable farms.

Suggested readings

1. Bose and Som 2003. Vegetable Crops. Vol I II and III. Naya Prokash.
2. Dhaliwal M S 2014. Handbook of Vegetable Crops. Kalyani Publishers.
3. Fageria M S, Choudhary B R and Dhaka Vegetable Crop Production Technology Vol II. Kalyani Publishers.
4. Hazara and Som 2015. Technology for Vegetable Production and Improvements. Naya Prokash
5. ICAR 2019. Handbook of Horticulture Vol 1 and Vol 2, ICAR.

HORT – 254 COMMERCIAL FRUIT PRODUCTION 4(3+1)

Objectives

To acquaint the students with the cultivation techniques for commercially important tropical, sub-tropical and temperate fruit crops

Theory

Area, production and export potential, varieties, soil and climate requirements, propagation techniques, planting density and systems, training and pruning, high

density planting, ultra-high density planting, mechanization, management of water, nutrient and weeds, Physiological disorders, Special production problems, insect-pests, diseases and their control measures. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops: mango, banana, citrus, guava, litchi, grapes, papaya, pineapple, ber, aonla, pomegranate, sapota, jamun, date palm, apple, pear, peach, plum, cherry, almond, apricot, walnut, kiwifruit, hazelnut, chestnut, pecan nut, plantation crops (coconut, cashew nut, tea, coffee, cocoa, arecanut, palmyrah palm and strawberry.

Practical

Description and identification of varieties. Training and pruning, application of manure, fertilizer and irrigation, weed control, maturity standards, harvesting, handling, grading and Packaging of fruits. Visit to commercial orchards.

Suggested readings

1. Bal J S. Fruit Growing.
2. Chattopadhyay T K. A Textbook on Pomology Vol I-IV.
3. George Acquaah. Horticulture Principles and Practices.
4. ICAR. Handbook of Horticulture Vol I-II.
5. Singh Ranjit. Fruits. New Book Trust, New Delhi, 303 p.

AEN(H) 255 PEST MANAGEMENT OF HORTICULTURE CROPS 3(2+1)

Theory

Classification of insect-pests. Dynamics of EIL and ETL. Methods of pest control - host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Recent technologies for insect-pest management. Insecticides, classification, formulations, first aid and antidotes. IPM – importance and principles. Scientific name, order, family, host range, distribution, biology, ecology, nature of damage and management of important insect-pests of various fruit (tropical, sub-tropical and temperate), vegetable, ornamental, plantation, spice, medicinal, aromatic crops and under protected conditions. Pest surveillance. Storage insects – Scientific name, order, family, host range, distribution, biology, ecology, nature of damage and management of important insect-pests attacking stored fruit, vegetable, plantation, ornamental, spice, medicinal and aromatic crops' produce and their processed products. Insecticides residue problems in fruit, vegetable, plantation, ornamental, spice, medicinal and aromatic crops and their maximum residue limits (MRLs). Waiting periods for insecticides on various crops.

Practical

Identification of insect-pests of various fruit, vegetable, plantation, ornamental, spice, medicinal and aromatic crops in field and their produce during storage, and their symptoms of damage. Identification of biocontrol agents and natural enemies. Insecticide formulations. Pesticide application appliances. Calculation of insecticide quantity for preparing spray material.

Suggested readings

1. Integrated Pest management concepts and approaches by G S Dhaliwal and Ramesh Arora
2. Agricultural Pests of South Asia and their Management by A S Atwal and G S Dhaliwal
3. Essentials of Agricultural entomology by G S Dhaliwal, Ram Singh and B S Chillar
4. Applied Animal Ecology by A S Atwal and S S Bains

AMP(H) – 256 INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE 2(1+1)

Objectives

Training graduate students with respect to management the climate aberration for sustainable crop production

Theory

Meaning and scope of agricultural meteorology; Earth atmosphere: its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Application of Thermal time concept and Crop/ Pest weather calendar; Energy balance of earth; Atmospheric humidity, concept of saturation, vapour pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon-mechanism and importance in Indian agriculture; Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave; Agriculture and weather relations; Modifications of crop microclimate, climatic normal for crop and livestock. Climate change and its impact on crop production.

Practical

Visit of Agro-meteorological Observatory, site selection of observatory, exposure of instruments and weather data recording, Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS; Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis, Measurement of soil temperature. Determination of vapor pressure and relative humidity, Determination of dew point temperature, Measurement of atmospheric pressure. Measurement of wind speed and wind direction, preparation of wind rose, Measurement, tabulation and analysis of rainfall. Measurement of open pan evaporation. Crop weather calendar.

Suggested readings

1. Avi H S 1985. Introduction to Agrometeorology. Oxford and IBH Publishing Co., New Delhi.
2. Lenka D 2006. Climate, Weather and Crops in India. Kalyani Publishers, New Delhi.

3. Mavi H S and Tupper G J 2005. Agrometeorology – Principles and applications of climate studies in agriculture. International Book Publishing Co., Lucknow.
4. Mavi H S 1994. Introduction to Agrometeorology. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
5. Nanjappa H V and Ramachandrappa B K 2007. Manual on Practical Agricultural Meteorology. Agrobios India. Jodhpur.
6. Pattersen S 1958. Introduction to Meteorology. Mc. Graw Hill Book Co. Inc., New York
7. Prasad Rao G S L H V 2008. Agricultural Meteorology. Prentice Hall of India Pvt. Ltd., New Delhi.
8. Srivastava A K and Tyagi P K 2011. Practical Agricultural Meteorology. New Delhi Publishing Agency, New Delhi.
9. Yellamanda Reddy T and Sankara Reddi G H 2010. Principles of Agronomy. Kalyani Publishers, New Delhi

SEC (VI) – 261 MICROPROPAGATION TECHNOLOGIES 2(0+2)

Objectives

To educate the students in detail about the sterilization techniques for explants, preparation of stocks and working solution, culturing of explants, regeneration of whole plants from different explants and hardening procedures.

Practical

Identification and use of equipments in tissue culture Laboratory, Nutrition media composition, sterilization techniques for media, containers and small instruments, sterilization techniques for explants, Preparation of working medium, Culturing of explants: Seeds, shoot tip and single node, Callus induction, indirect regeneration of whole plants from different explants, Primary and secondary hardening procedures.

Suggested readings

1. Plant Tissue Culture: Basic and Applied by Timir Baran Jha and Biswajit Ghosh, 2016, Platinum Publishers, 439p.
2. Plant Tissue Culture: Theory & Practice by S.S. Bhojwani & M.K. Razdan, 1996, Elsevier

SEC (VI) - 262 LANDSCAPE GARDENING 2(0+2)

Practical

Identification and use of garden tools and equipment. Study of growth characters, identification and classification of ornamental trees, shrubs, climbers, ground covers and indoor plants. Making and maintenance of edge, hedge and topiary. Establishment and maintenance of a lawn. Bonsai making. Art principles of landscaping. Formal and informal gardens. Planning, designing and establishment of garden features. Landscape design process: Landscape drafting tools. Dimensioning, graphic symbols and notations. Site analysis and landscape designing of residential, public buildings and religious places. Landscape planning of roads and roundabouts. Visit to community parks and Institutional gardens.

SEC (VI) – 263 BIOFERTLIZER PRODUCTION TECHNOLOGY 2(0+2)

Practical

Acquaintance with the Development biofertilizer production unit. Types of biofertiliaers. Production technology: Isolation and purification of *Azospirillum, Azotobacter, Rhizobium*, P-solubilizers and cyanobacterial biofertiliaer; preparation of culture media and sterilization, mass culturing of microbial inoculants in fermenter. Preparation of carrier based and liquid biofertiizers. Quality control of biofertilizers. Methods of biofertilizer application

SEC (VI) - 264 PRODUCTION OF MICROBIAL BIOCONTROL AGENTS 2(0+2)

Practical

Scope and importance of microbial biocontrol agents in agriculture. Status of microbial biocontrol agents' production and marketing. Acquaintance with microbial biological control agents mainly *Trichoderma, Bacillus*and *Pseudomonas fluorescence*. Biocontrol laboratory facilities required for mass production of biological control agents. Media used for isolation, numeration, purification and maintenance of biocontrol agents. Different methods for identification of biocontrol agents. Assay for antagonistic activity and plant growth promotion potentiality of biocontrol agents. Mass production of biocontrol agents. Quality control of biocontrol agents, Economics involved in commercial production. Benefit Cost ratio. Method of applications of biocontrol agents. Registration of biocontrol agents. Marketing strategy - product promotion and sale.

SEMESTER V

CC – 301 AGRICULTURAL MARKETING AND TRADE 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets, Demand, supply and producer's surplus of agri-commodities: nature and determinants of demand and supply of farm products, producer's surplus of agri-commodities. Pricing and promotion strategies pricing considerations and approaches, cost-based and competition based pricing; Market promotion, advertising, personal selling sales promotion and publicity-meaning, merits and demerits: Marketing process and functions Marketing process concentration, dispersion and equalization, exchange functions; buying and selling physical functions storage, transport and processing facilitating functions – packaging, branding,

grading, quality control and labelling (Agmark), Market functionaries and marketing channels; Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; Marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency marketing costs margins and price spread, factors affecting cost of marketing reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: public sector institutions –CWC, SWC,FCI, CACP and DMI-their objectives and functions; cooperative marketing in India. Risk in marking: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri- commodities, WTO, Agreement on Agriculture (AOA) and its implications on Indian agriculture; IPR, Role of government in agricultural marketing; Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities study of relationship between market arrivals and price of some selected commodities computation of marketable and marketed surplus of important commodities study of price behavior over time for some selected commodities construction of index number Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity collection of data regarding marketing costs margins and price spread and presentation of report in the class visit to market institution –NAFED, SWC,CWC, cooperative marketing society etc. to study their organization and functioning application of principles of comparative advantage of international trade.

Suggested readings

1. Acharya, S.S. and Agarwal N.L.2006 Agricultural Marketing in India, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
2. Chinna S.S. 2005 Agricultural Economics and Indian Agricultural Kalyani Pub, N.Delhi.
3. Kohls Richard L. and Uhl Josheph N.2002 Marketing of Agricultural products, Prentice –Hall of India private Ltd, New Delhi.
4. Kotler and Armstrong 2005 principles of Marketing. Pearson Prentice Hall.
5. Lekhi R. K. and Joginder Singh 2006 Agricultural Economics. Kalyani publishers, Delhi. Memorial C.B.
6. Joshi R.L. and Mulla N.I. 2003 principles and practice of Marketing in India Kitab Mahal, New Delhi.
7. Pandey Muhesh and Tewari, Deepali 2004 Rural and Agricultural Marketing international Book Distributing Co. Ltd, New Delhi.
8. Sharma R. 2005 Export Management Laxmi Narain Agarwal, Agra.

GPB(H) – 302 FUNDAMENTALS OF PLANT BREEDING 3(2+1)

Theory

Historical development, concept, nature and role of plant breeding. Major achievements and future prospects. Genetics in relation to plant breeding. Modes of reproduction. Male sterility - genetic consequences and cultivar options. Domestication, acclimatization and introduction. Centres of origin/diversity. Components of genetic variation, heritability and genetic advance. Genetic basis and breeding methods in self-pollinated crops - mass and pure line selection, hybridization techniques and handling of segregating population. Multiline concept. Concepts of population genetics and Hardy-Weinberg Law. Genetic basis and methods of breeding cross - pollinated crops. Modes of selection. Population improvement schemes - ear to row method, modified ear to row, recurrent selection schemes. Heterosis and inbreeding depression. Development of inbred lines and hybrids, composite and synthetic varieties. Breeding methods in asexually propagated crops – clonal selection. Wide hybridization and pre-breeding. Polyploidy in relation to plant breeding. Mutation breeding - methods and uses. Breeding for important biotic and abiotic stresses. Introduction to biotechnological tools - DNA markers and marker assisted selection. Participatory plant breeding. Plant Breeders' and Farmers' Rights.

Practical

Plant breeder's kit. Study of germplasm of various crops. Study of floral structure of self-pollinated and cross pollinated crops. Emasculation and hybridization techniques in self and cross-pollinated crops. Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregation populations. Maintenance of breeding records and data collection. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiments, analysis of Randomized Block Design. Working out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of double cross hybrids.

Suggested Readings

1. Chahal GS and Gosal SS. 2001. Principles and Procedures of Plant Breeding.
2. Fehr WR. 1987 Principles of Cultivar Development –Theory and Practice.
3. Poehlman JM and Sleper DA.1995. Breeding Field Crops.
4. Singh BD 2011. A text book in Plant Breeding, Kalyani Publishers, Ludhiana.
5. Singh BD. 2008 Plant Breeding – Principles and Methods.

HORT – 303 GROWTH AND DEVELOPMENT OF HORTICULTURE CROPS 3(2+1)

Objectives

1. To understand the physiology of canopy management, flowering, fruit setting and seed development in horticultural crops
2. To impart basic knowledge on the natural phytohormones and their specific functions in controlling the growth and developments
3. To impart basic knowledge on the natural phytohormones and their specific functions in controlling the growth and developments

4. To understand the usage of synthetic growth regulators and their applications for overall manipulation of growth and development in horticultural crops

Theory

Growth and development-definitions, components, photosynthetic productivity, Canopy photosynthesis and productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, Crop development and dynamics (Case studies of annual/perennial horticultural crops), growth analysis in horticultural crops. Plant bio-regulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop, and fruit ripening. Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neutral plants, vernalization and its application in horticulture, pruning and training physiological basis of training and pruning source and sink relationship, translocation of assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climatic and non-climacteric fruits. Physiology of fruits under postharvest storage.

Practical

Estimation of photosynthetic potential of horticultural crops, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, identification of synthetic plant hormones and growth retardants, preparations of hormonal solution and induction of rooting in cuttings, ripening of fruits and control of flower and fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables, seed dormancy, seed germination and breaking seed dormancy with chemicals and growth regulators.

Suggested readings

1. Jain V K 2006. Fundamentals of plant physiology (Ninth edition). S, Chand and Co., New Delhi, India.
2. Mohr H and Schopfer P 1995. Plant Physiology. Springer-Verlag, Berlin, Germany.
3. Richard P Marini: Physiology of Pruning Fruit Trees. http://pubs.ext.vt.edu/422/422-025/422025. htmlTOC.
4. Salisbury F B and C W Ross 1992. Plant physiology (Fourth edition). Wadworth publishing Co., California, USA.
5. Taiz L and Zeiger E 2003. Plant physiology (Third edition). Sinaure Associates, Inc., Publishers, Massachusetts, USA.

ACSS(H) – 304 SOIL FERTILITY AND NUTRIENT MANAGEMENT 3(2+1)

Objectives

To acquaint students with the basic knowledge of soil fertility and nutrient management, as to understand the key factors affecting plant growth and development.

Theory

Plant nutrients - classification and sources; Essential and beneficial elements, criteria of essentiality, forms of nutrients in soil, mechanisms of nutrient transport to plants, factors affecting availability of major, secondary and micro-nutrients to plants. Measures to overcome deficiency and toxicities. Soil fertility- different approaches for soil fertility evaluation; Soil testing for available nutrients; Critical levels of different nutrients in soil. Plant analysis- total and rapid tissue tests critical levels of nutrients in plants; DRIS method; Deficiency symptoms-indicator plants. Biological method of soil fertility evaluation. Soil test-based fertilizer recommendations to crops. Site-specific and plant need-based nutrient management. Factors influencing nutrient use efficiency (NUE) in respect of N, P, K, S, Fe and Zn fertilizers. Source, method and scheduling of nutrients for different soils and crops grown under rainfed and irrigated conditions. Integrated plant nutrient supply system and its management. Soil quality in relation to sustainable agriculture-acid, salt affected and calcareous soils, characteristics, nutrient availabilities, Reclamation- mechanical, chemical and biological methods.

Practical

Analytical Instruments- principles, calibration and applications; Estimation of available nitrogen, available phosphorus, available potassium and available sulphur in soil; Estimation of exchangeable calcium and magnesium in soil, Estimation of available micronutrients in soils; Preparation of plant samples for analysis; Estimation of nitrogen, phosphorus and potassium in plants.

Suggested readings

1. Aggarwal JP Yawalkar KS and Bokde S 2011. Manures and Fertilizers 11th edn. Agri Horticultural Publishing House. Nagpur.
2. Basak Ranjan Kumar 2016. Fertilizers A Text Book, Fourth edition. Kalyani Publishers. Ludhiana.
3. Brady NC 1999. Nature and Properties of Soils 10th Edition.
4. Das PC 2015. Manures and Fertilizers Third edition Kalyani Publishers. Ludhiana.
5. Goswami NN. 2009. Fundamentals of Soil Science 2nd Edition. ISSS New Delhi.
6. Kanwar JS. Soil Fertility Theory and Practice ICAR. New Delhi.
7. Soil Science an Introduction 2015. Indian Society of Soil Science. New Delhi.
8. Tisdale SL Nelson WL and Beaton JD 1985. Soil Fertility and Fertilizers 4th Edition. MacMillan Publishing Company. New York.

ACSS(H) – 305 GENERAL MICROBIOLOGY 3(2+1)

Objective

To provide knowledge about general concepts of microbiology.

Theory

Evolution and scope of microbiology. History of microbiology. Microbial classification, nomenclature and identification. Taxonomic groups. General methods of classifying bacteria. Microscopy and microscopes: Smears and staining. Morphology and fine

structure of bacteria. Cultivation of bacteria, nutritional requirements. Nutritional classification of bacteria; phototrophs, chemotrophs, autotrophs and heterotrophs; Obligate parasites; Bacteriological media, Growth of bacteria, Reproduction of bacteria; Introduction to fungi, algae and protozoa and virus, Food Microbiology: Microbial spoilage and principles of food preservations, Food poisoning**.** Metabolism in bacteria –ATP generation Microbial genetics; Bacterial recombination; Bacterial conjugation, transduction; Bacterial transformation; Mutations: Types of mutations, mutagenesis; Destruction of microorganisms: Physical agents and chemical agents; Characteristics of antibiotics; Mode of action of antibiotics; Pure culture: Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Nutrient transformation in soil: C, N, P and S, Biological Nitrogen Fixation, Nutrient transport phenomenon: Passive diffusion, facilitated diffusion; Group translocation, active transport. Rhizosaphere and Phyllosphere microflora.

Practical

Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (monochrome staining, Gram staining, negative staining, capsule-staining, flagella staining and endospore staining); Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics); Growth characteristics of fungi: Determination of microbial numbers, direct plate count, generation time; Factors influencing growth: pH, temperature, growth curves for bacteria.

Suggested Readings

1. Dubey RC and Maheshwari DK. 2013. A Textbook of Microbiology S Chand Publishing, New Delhi.
2. Gerard JT, Berdell RF and Christine LC. 2014. Microbiology: An Introduction. 12th edn. Prentice-Hall, NY, USA.
3. Johanne MW, Linda MS and Woolverton CJ. 2013. Prescott's Microbiology. 9th edn. McGraw- Hill Higher Education, NY, USA.
4. Pelczar MJ, Chan ECS and Noel RK. 1998. Microbiology. 5th edn. Tata McGraw-Hill Education, New Delhi.
5. Purohit SS. 2001. Microbiology-Fundamentals and Applications. Agrobios, New Delhi.
6. Sharma PD. 1999. Microbiology. Rastogi Publications, Meerut, India.
7. Tauro P, Kapoor KK and Yadav KS. 2002. Introduction to Microbiology. New Age International (P) Limited Publications, New Delhi, India.

AEX(H) – 306 INFORMATION AND COMMUNICATION TECHNOLOGY IN HORTICULTURE 3(2+1)

Objectives

To learn basics of computing and its practical use in communication

Theory

IT and its importance. IT tools, IT-enabled services and their impact on society; Introduction to Computers, hardware and software; input and output devices; word

and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; Operating Systems, definition and types, Applications of Word Processing / Spreadsheet /Presentation /Databases for document creation and Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database concepts and types, uses of DBMS in Horticulture; Introduction to Local area network (LAN), Wide area network (WAN), Internet and World Wide Web, HTML and IP and Video conferencing, Introduction to e- Horticulture, concepts and applications, Use of ICT in Horticulture.

Practical

Practice with latest operating system for creating Files, Folders, File Management. Use of Word Processing/ Spreadsheet/ Presentation/ Databases with latest software packages; Creating a spreadsheet, Use of statistical tools, writing expressions, creating graphs, analysis of scientific data. Creating Database, preparing queries and reports, creation and operation of E mail account; Demonstration of Agri-information system using Mobile Apps. Internet applications: Web browsing, handling of audio-visual equipment. Planning, preparation, presentation of posters, charts. Introduction of Geospatial Technology of generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

Suggested readings

1. Comer Douglas E. 2018. The Internet book: everything you need to know about computer networking and how the Internet works. Chapman and Hall/CRC.
2. Crowther R, Joe L, Ash Blue, and Wanish G. 2014. HTML5 in Action. Manning.

PPH(H) – 307 INTRODUCTORY CROP PHYSIOLOGY 2(1+1)

Objectives

1. To study different physiological plant aspects such as water uptake and movement in plants, nutrient absorption, assimilation
2. To study factors affecting photosynthesis and its importance in plants

Theory

Water Relations in Plants: Role of water in plant metabolism, osmosis imbibition, diffusion, water potential and its components, measurement of water potential in plants, absorption of water, mechanism of absorption and ascent of sap. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, guttation, stem bleeding; transpiration methods and mechanism and factors affecting transpiration. Drought: Different types of stresses; water, heat and cold tolerance; mechanism of tolerance. Plant Nutrition: Essentiality, mechanism of absorption and its role in plant metabolism. Photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and non-cyclic electron transfer, CO2 fixation – C3, C4 and CA metabolism, advantages of C4 pathway. Photorespiration and its implications, factors affecting photosynthesis. Mode of herbicide action, Secondary metabolites and plant defense.

Practical

Preparation of standard solutions, units of concentration and dilution. Measurement of water potential, osmosis, root pressure, structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpiration pull demonstration. Importance of light and chlorophyll in photosynthesis, determination of the rate of photosynthesis, pigment identification in horticultural crops, measurement of relative water content (RWC), studying plant movements.

Suggested Readings

1. Bendre AM and Pande PC, 2009, Introductory Botany. Rastogi publication, Meerut.
2. Bhatia KN, 2015, Plant Physiology. Trueman Book Company, Jalandhar.
3. Dutta AC, 2013, A Textbook of Botany. Oxford University Press, Oxford Lecture Schedule.
4. Gardner FP, Pearce R Band Mitchell RL, 2003, Physiology of Crop Plants. Scientific Publishers, Jodhpur.
5. Jain V K, 2019, Fundamentals of Plant Physiology. S Chand Publishers, New Delhi.

AST(H) – 308 BASIC STATISTICS AND EXPERIMENTAL DESIGNS 3(2+1)

Objectives

1. To understand the analytical techniques for data analysis and interpretation
2. To help students to compete for various competitive examinations

Theory

Definition of statistics, its use and limitations. Variable statistics, types and sources of data, classification and tabulation of data. Construction of frequency distribution tables – graphic presentation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve, cumulative frequency curve. Measures of central tendency: mean, median, mode, geometric mean, harmonic mean, percentiles and quartiles for raw and grouped data, Measures of dispersion: range, quartile deviation, mean deviation, standard deviation for raw and grouped data, coefficient of variation. Skewness and kurtosis. Probability definition, additive and multiplicative law for two events, Normal distribution and its properties. Introduction of sampling. basic concepts, sampling vs. Complete enumeration parameter and statistic. Sampling techniques (simple random sampling: lottery method and random number table method). Tests of significance, Null hypothesis, Alternate hypothesis, Type I and II Error, one and two tail tests, level of significance and confidence interval. Large sample tests for mean (Single sample and two samples), Student's t-test for single sample, two samples and paired t-test, F-test, Chisquare test for application of attributes (contingency table) and test for goodness to fit of Mendalian ratios, Yates' correction for continuity. Correlation-scatter diagram and Karl Pearson coefficient of correlation for ungrouped data and its testing. Linear regression and its properties. Inter-relation between 'r' and the regression coefficient, Introduction to design of experiment- Basic principles of experimental design-replication, randomization and local control, Analysis of variance (ANOVA) and its

assumptions, analysis of Completely Randomized Design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD), Comparisons based on means-critical difference.

Practical

Construction of frequency distribution tables and frequency curves, Measures of central tendency: mean, median, mode, geometric mean, harmonic mean, percentiles and quartiles. Measures of dispersion: range, quartile deviation, mean deviation, standard deviation for raw and grouped data, coefficient of variation. Skewness and kurtosis. Probability. Large sample tests for mean, Student's t-test, F-test and Chi-square test, Correlation coefficient 'r' and its testing, Fitting of regression equations, Analysis of CRD, RBD and LSD.

Suggested Readings

1. Bansal M L, Singh Sukhminder, Singh Tejinderpal and Jindal Rakesh Kumar. 2014. Statistical Methods for Research Workers. Kalyani Publishers 4th edn.
2. Chandal S R S.2014. A Handbook of Agricultural Statistics. Achal Prakashan Mandir.
3. Gupta S P. 2021. Statistical Methods. Sultan Chand and Sons.
4. William G Cochran and George W Snedecor. 2014. Statistical Methods. Wiley India Pvt Ltd. 8th edn.

SEMESTER VI

SWC(H) – 351 INTRODUCTORY AGROFORESTRY 3(2+1)

Objective

To develop skill and expertise on forestry, agroforestry models, wood-based industries, and nursery raising practices of important tree species

Theory

Forestry – Introduction, related definitions. Objective of silviculture. Forest classification. Indian Forest Policies. Artificial and natural regeneration – objectives, choice between natural and artificial regeneration. Coppicing, pollarding, root suckers. Forest mensuration – objectives, instruments for diameter, height and age measurement. Tree stem form, form factor, form quotient. Measurement of volume of felled and standing trees.

Agroforestry – definition, objectives and potential. Distinction between agroforestry and social forestry. Choice of species with respect to site/economic uses and constraints on tree growing. Agroforestry systems, sub-systems and practices, shifting cultivation, taungya, home gardens, alley cropping, intercropping, wind breaks, shelterbelts and energy plantations. Planning for agroforestry – constraints, diagnosis and design methodology, selection of tree - crop species for agroforestry. Agroforestry projects – national and overseas. National Agroforestry Policy 2014. MPTs (*Azadirachta indica, Acacia* species, Bamboos, *Dalbergia sissoo*, *Eucalyptus* species, *Grewia optiva*, *Gmelina arborea*, *Leucaena leucocephala, Melia* species, *Populus deltoides*, *Tectona grandis*, etc.) – nursery and planting management practices.

Major wood-based industries in India – Timber, panel, plywood, paper and pulp, match, etc. – Raw material requirements and their procurement. Economics and marketing of products raised in agroforestry systems.

Practical

Identification of seeds and seedlings of tree species. Diameter measurements of forked, buttressed, fluted and leaning trees. Height measurement of standing trees by shadow method, single pole method and hypsometer. Volume measurement of logs using various formulae. Nursery practices for *Azadirachta indica, Acacia* species, Bamboos, *Dalbergia sissoo*, *Eucalyptus* species, *Grewia optiva*, *Gmelina arborea*, *Leucaena leucocephala, Melia* species, *Populus deltoides*, *Tectona grandis*, etc. Layout of agroforestry plantation and study the compatibility of MPTs with agricultural crops. Visit to social forestry/agroforestry plantations and nearby forest-based industries.

Suggested readings:

1. Chundawat DS and SK Gautham. 2017. Textbook of Agroforestry. Oxford and IBH Publishing, (ISBN: 9788120408326).
2. Nair PKR, Kumar BM and VD Nair. 2021 An introduction to agroforestry – four decades of scientific developments. DOI: https://doi.org/10.1007/978-3-030-75358-0.
3. Parthiban KT, Umarani R, Kanna SU, Sekar I, Rajendran P and Durairasu P. 2014. Industrial agroforestry - Perspectives and Prospective. Scientific Publishers, Jodhpur.
4. Tejwani KG. 2001. Agroforestry in India. Concept Publishing Company.

HORT – 352 LABORATORY TECHNIQUES FOR HORTICULTURE CROPS 2(0+2)

Objectives

1. To impart practical training for the analysis of physio-chemical attributes of fruit.
2. To acquaint students with operating of various labware and equipment's

Practical

Safety measures and maintenance of laboratory. Acquaintance with the laboratory equipment's used for quality analysis of fruits and vegetables. Preparation of different standard solutions. Sampling procedures for quantitative analysis. Determination of physiological loss in weight, specific gravity, fruit size, shape, juice content, firmness and fruit colour. Assessment of textural properties of harvested produce. Determination of biochemical components in horticultural produce viz. TSS, pH, acidity, sugars, carbohydrates, total antioxidants, starch index (SI), ascorbic acid, chlorophyll, anthocyanin, and carotenoids, phenols. Leaf nutrient analysis using Kjeldahl apparatus, spectrophotometer, flame photometer and atomic absorption spectrophotometer. Compilation and analysis of data and interpretation of results.

Suggested readings

1. AOAC International 2003. Official Methods of Analysis of AOAC International. 17th edn. Gaithersburg MD USA Association of Analytical Communities USA.
2. Rangana S 2001. Handbook of Analysis and Quality control for fruits and vegetable
3. products.2nd edn. Tata McGraw Hill. New Delhi.
4. Linskens H F and Jackson J F 1995. Fruit Analysis Springer.

5. Leo M L 2004. Handbook of Food Analysis 2nd edn. Vols I-III USA.
6. Sarkar A K and Mahapatra 2015. Plant nutrient disorders diagnosis and management. New India Publishing Agency. New Delhi, India.

ABC (H) – 353 PRINCIPLES OF BIOCHEMISTRY 3(2+1)

Objectives

To impart the fundamental knowledge on structure and function of cellular components, biomolecules and the biological processes in plants

Theory

Biochemistry – Introduction and importance, Properties of water, pH and buffer, plant cell and its components.
Bio-molecules – Structure, classification, properties and function of carbohydrates, amino acids, proteins, lipids and nucleic acids.
Enzymes: general properties and classification; mechanism of action; factors affecting enzymatic reaction, Michaelis-Menten and Lineweaver - Burk equation & plots, regulation of enzyme activity; introduction to allosteric enzymes, Vitamins – physiological and metabolic role.
Metabolic energy and its generation – Metabolism – Basic concepts.
Catabolism of Carbohydrate: Glycolysis, Pentose phosphate pathway, TCA cycle, glyoxylate cycle, electron transport chain and oxidative phosphorylation.
Fatty acid and Amino acid catabolism: Degradative pathway and Regulation of metabolic pathways.

Practical

Preparation of standard solutions and reagents, Determination of pH, Qualitative tests of carbohydrates and amino acids, Quantitative estimation of soluble sugars and reducing sugar, Estimation of soluble protein by Lowry's method, Estimation of fat by Soxhlet method, Determination of acid value, saponification value and iodine number, Estimation of ascorbic acid, Enzyme assay.

Suggested readings

1. Nelson and Cox. 2008. Lehninger Principles of Biochemistry. Fourth/Fifth edition. Freeman
2. Conn, Stumpf, Bruening and Doi. 2006. Outlines of Biochemistry. Fifth Edition. Wiley
3. Horton, Moran, Rawn, Scrimgeour
4. Perry. 2011. Principles of Biochemistry. Fifth Edition. Pearson/Prentice Hall (Can be downloaded)
5. Heldt. 2005. Plant Biochemistry. Elsevier (Can be downloaded)
6. Goodwin and Mercer. 2005. Introduction to Plant Biochemistry. 2nd edition. CBS.
7. Biochemistry by Donald Voet and Judith G. Voet. Fourth Edition. Wiley

HORT – 354 DRYLAND HORTICULTURE 3(2+1)

Objectives

1. To acquaint the students with the soil and climatic features of the dry land areas

2. To impart the knowledge about the soil and water conservation technologies for dry land areas
3. To impart the knowledge about the production technologies for fruit crops of dry land areas

Theory

Definition, importance and limitation of dry land horticulture, present status and future scope. Constraints encounter in dry lands. Agro-climatic features in rainfed areas, scarce water resources, high temperature, soil erosion, run-off losses etc. Techniques and management of dry land horticulture. Watershed development, soil and water conservation methods-terraces, contour bunds etc. Methods of control and impounding of run-off water-farm ponds, trenches, macro catch pits etc. In-situ water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, anti-transpirants, growth regulators, organic amendments etc. water use efficiency-need based, economic and conjunctive use of water, micro irrigation systems and fertigation etc. Water quality: characterization and use in horticultural crops. Selection of plants having drought resistance. Special techniques, planting and after care-use of seedling races, root stocks, in-situ grafting, deep pitting/planting, canopy management etc. Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

Practical

Rainfall patterns. Contour bunding/trenching, micro catchments; rainfall erosivity and soil erodibility indices, measurement of runoff, soil loss and their control. Study of evapotranspiration, mulches and micro irrigation systems. Special techniques of planting and aftercare in dry lands. Morphological and anatomical features of drought tolerant fruit crops.

Suggested readings

1. Chundawat B S 1990 Arid Fruit Culture. Oxford and IBH, New Delhi.
2. Jatav M K, Saroj P L and Sharma B D 2019. Dryland Horticulture. New India Publishing Agency.https://www.perlego.com/book/1975613/dryland-horticulture-pdf ISBN 10.1201/9781003245902.
3. Rathore R S, Singh R P, Singh P K and Singh P S 2020 Dryland Horticulture Cultivation and Management. Publisher AGROBIOS (INDIA) ISBNs: 978-81-943776-5-8 pp: 1-340
4. Singh Jitendra 2022 Drylands Horticulture, ISBN: 9789355400048

AEC(H) – 355 ECONOMICS AND MARKETING 3(2+1)

Objectives

1. To introduce the student about the concepts, subject matter and importance of study of economics.
2. To make the student understand about the terms - goods, service, value, price, wealth, welfare.

3. To impart knowledge to the student about the concept of wants, utility and consumer surplus.
4. To expose the students to the laws of marginal utility and their importance.
5. To provide an overview to the students about the concept of demand, kinds of demand and law of demand.
6. To aware the student about the concept of supply, law of supply and price determination of commodity under equilibrium condition.
7. To aware the student about factors of production and their characteristics
8. To provide an overview to the student about the Gross Value Added.
9. To expose the students to the concept of marketing, market, price spread, marketing efficiency, integration, marketing functions, classification of markets and marketing channels.
10. To aware the students about the market intelligence, constraints in marketing of agricultural produce.
11. To impart knowledge to the student about Basic guidelines for preparation of project reports, Bank norms, Insurance, SWOT analysis, crisis management.

Theory

Economics – Terms and definitions; Consumption, demand, price and supply; Factors of production; Gross Value Added. Role of Biotechnology/Agriculture Sector in National GVA. Marketing – definition; Marketing process; Need for marketing; Role of marketing; Marketing functions; Classification of markets; Marketing of various channels; Price spread; Marketing efficiency; Constraints in marketing of agricultural produce; Market intelligence. Basic guidelines for preparation of project reports; Bank norms; Insurance; SWOT analysis; Crisis management.

Practical

Techno-economic parameters for preparation of projects; Preparation of bankable projects for various biotechnology/ agricultural products and value-added products; Identification of marketing channel; Calculation of price spread; Identification of market structure; Visit to different markets, market institutions; Study of SWC, CWC and STC; Analysis of information of daily prices; Marketed and marketable surplus of different commodities.

Suggested Readings

1. Acharaya S S and Aggarwal N L, Agricultural Marketing in India.
2. Gupta R D, Elementary Economic Theory.
3. Dewett K K, Modern Economic Theory.
4. Dewett K K and Verma J D Elementary Economic Theory.
5. Reddy Subba S, Raghu Ram P, Neelkanta T V and Bhawani Sastry Devi, Agricultural Economics.

AGR – 356 PRINCIPLES AND PRACTICES OF NATURAL FARMING 2(1+1)

Objectives

1. To teach students the concept, need and principles of native ecology-based production under natural farming

2. To impart practical knowledge of natural farming and related agricultural practices in Indian and Global environmental and economic perspectives.

Theory

Indian Heritage of Ancient Agriculture, History of Natural Farming, Importance of natural farming; Definition; Objective of natural farming, Essential characteristics and Principles of natural farming; Scope and importance of natural farming. Main Pillars of natural farming; Methods/ types/ schools of natural farming. Introduction to concept of ecological, water, carbon and nitrogen foot prints, Concept and evaluation of ecosystem services, Rearing practices for animals under natural farming**,** Nutrient management in natural farming and their sources, Insect, pest, disease and weed management under natural farming; Mechanization in natural farming, Processing, labelling, economic considerations and viability, certification and standards in natural farming, marketing and export potential of natural farming produce and products. Initiatives taken by Government (central/state), NGOs and other organizations for promotion of natural farming and chemical free agriculture, Case studies and success stories in natural farming and chemical free traditional farming, Entrepreneurship opportunities in natural farming.

Practical

Visit of natural farm and chemical free traditional farms to study the various components and operations of natural farming principles at the farm; Indigenous technical knowledge (ITK) for seed, tillage, water, nutrient, insect-pest, disease and weed management; On-farm inputs preparation methods and protocols, Studies in green manuring *in-situ* and green leaf manuring, Studies on different types of botanicals and animal urine and dung based non-aerated and aerated inputs for plant growth, nutrient, insect and pest and disease management; Weed management practices in natural farming; Techniques of indigenous seed production, storage and marketing, Partial and complete nutrient and financial budgeting in natural farming; Evaluation of ecosystem services in natural farming (Crop, Field and System).

Suggested Readings

1. Ayachit SM. 2002. Kashyapi Krishi Sukti (A Treatise on Agriculture by Kashyapa). Brig Sayeed Road, Secunderabad, Telangana: Asian Agri-History Foundation 4: 205.
2. Boeringa R. (Eed.). 1980. Alternative Methods of Agriculture. Elsevier, Amsterdam, 199 pp.
3. Dabholkar Shripad A. 2021. Plenty For All: Natural Farming A To Z Prayog Pariwar Methodology and Prayog Pariwar Prayog Pariwar.
4. Das P, Das S K, Arya H P S, Reddy G Subba, Mishra A and others: Inventory of Indigenous Technical Knowledge in Agriculture: Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge, Document 1 To 7, Indian Council of Agricultural Research, New Delhi.
5. Ecological Farming -The seven principles of a food system that has people at its heart. May 2015, Greenpeace.
6. Faires Nicole. 2016. The Ultimate Guide to Natural Farming and Sustainable Living: Permaculture for Beginners (Ultimate Guides).

7. FAO. 2018. The 10 elements of agro-ecology: guiding the transition to sustainable food and agricultural system. https://www.fao.org/3/i9037en/i9037en.pdf Agro ecosystem Analysis for Research and Development Gordon R. Conway.1985
8. Fukuoka M. 1978. The One-Straw Revolution: An Introduction to Natural Farming. Rodale Press, Emmaus, PA. 181 pp
9. Fukuoka M. 1985. The Natural Way of Farming: The Theory and Practice of Green Philosophy. Japan Publications, Tokyo, 280 pp.
10. Hill S B and Ott P (Eds.). 1982 Basic Techniques in Ecological Farming. Berkhauser Verlag, Basel, Germany, 366 pp.
11. HLPE. 2019. Agroeeological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and nutrition of the Committee on World Food Security, Rome. https://fao.org/3/ea5602en/ea5602en.pdf.
12. INFRC. 1988. Guidelines for Nature Farming Techniques. Atami, Japan. 38 pp.
13. Khurana A and Kumar V. 2020. State of Organic and Natural Farming: Challenges and Possibilities, Centre for Science and Environment, New Delhi.
14. Lindenmayer David B, Macbeth Suzannah M et al. 2022. Natural Asset Farming: Creating Productive and Biodiverse Farms.
15. Malhotra R and Babaji S D. 2020. Sanskrit Non Translatable- The importance of Sanskritizing English. Amaryllis, New Delhi India.
16. Nalini S. 1996. *Vrikshayurveda* (The Science of Plant Life) by Surapala. AAHF Classic Bulletin 1. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP (now Telengana), India. 94pp.
17. Nalini S. 1999. *Krishi-Parashara* by Parashara. Brig Sayeed Road, Secunderabad, Telangana: AAHF Classic Bulletin, Asian Agri-History Foundation. 104pp.
18. Nalini S. 2011. *Upavana Vinoda* by Sarangdhara: AAHF Classic Bulletin 8. Asian Agri-History Foundation, Brig Sayeed Road, Secunderabad, AP, India. 64p
19. Prathapan Paramu. 2021. Natural Farming Techniques: Farming without tilling.
20. Reyes Tirado. 2015. Ecological Farming- The seven principles of a food system that has people at its heart. Greenpeace Research laboratories. University of Exeter, Ottho Heldringstraat.
21. UK Behera. 2013. A text Book of Farming System. Agrotech Publishing House, Udaipur.

HORT – 357 HORTICULTURE BASED INTEGRATED FARMING SYSTEM 3(2+1)

Objective

To familiarize the students for farm management to deliver more sustainable agriculture

Theory

Farming System-scope, importance, concept and factors affecting types of farming system. Farming system components and their maintenance. Evolution and diversity of farming systems;

Stone age survival to swidden farming, Nomadic pastoralism and agro-pastoralism in warm and cold deserts of India. Horticulture crop based livestock farming, subsistent livelihoods in rain-fed areas of India. Industrial and semi-industrial agriculture- agro-enterprises, agribusiness systems, their produce for marketing grains, vegetables,

fruits, flowers, fibre crops, medicinal and aromatic plants. Value addition for income enhancement. Integrated farming system- objectives, characteristics and its advantages and disadvantages. Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques in relation to horticulture crops. Resource cycling and flow of energy in different horticulture- based farming system and environment. Sustainable livelihood agriculture- problems and its impact on horticulture. Indicators of soil health and environment for horticulture-based IFS. Vertical farming definition, their scope and objectives; multilayer farming, hydroponics, aeroponics-their definition, requirements, advantages, disadvantages and opportunities; Site specific horticulture- based IFS models; horticulture and vegetable intercropping systems; high density plantation; bankable IFS models; rooftop farming; Farm typology. Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers' field.

Practical

Preparation of horticulture based cropping scheme and integrated farming system models for irrigated, rainfed and dryland situations. Preparation of enriched farmyard manure and vermicompost. Visit to urban waste recycling unit and model farmers' field. Preparation of farm lay out plans. Estimating horticulture crop yields. Energy budgeting in different horticulture crops. EC/pH/TDS of water; Hydroponics nutrient management, Designing of polyhouse, Net house and tunnel house; Mushroom farming and its various types; Seeding with soilless media. C sequestration, budgeting, footprints. Organic fertigation in orchards; use of biorationales. Working out ecological optimum zones. Project making exercises for establishment of horticulture-based production models under different situation.

HORT – 358 PROCESSING AND VALUE ADDITION OF HORTICULTURE CROPS 3(2+1)

Objectives

1. To make the students familiarize with the principles of food preservation and processing
2. To develop the skill set in students for value addition of horticultural produce by application of suitable food processing methods

Theory

Importance and scope of fruit and vegetable processing industry in India. Food pipeline losses in postharvest, processing and distribution systems. Losses in post-harvest operations. Unit operations in food processing-pasteurization, sterilization, blanching, canning, and bottling.

Principles and guidelines for selecting the location and establishment of processing units. Principles and methods of preservation by heat, low temperature, sugar and salt, chemicals. Methods of fruit juice extraction, preparation of RTS, cordials, nectars, squashes, syrups, candies, crystallized fruits, preserves, jam, jelly, marmalade, fermented beverages, vinegar, pickles, chutneys and sauces. Tomato and mushroom products, freezing of fruits and vegetables. Drying of fruits and vegetables. Processing

of plantation crops, their products, spoilage in processed foods, quality control of processed products, Government policy on import and export of processed fruits. Food laws.

Practical

Equipment used in food processing units. Canning of fruits and vegetables. Preparation and quality evaluation of squash, RTS, syrup, jam, jelly, marmalade, candies, preserves, chutneys. Dehydration of fruits and vegetables, tomato products, refrigeration and freezing, cut out analysis of processed foods. Visit to food processing units.

Suggested readings

1. Fellows P J. 2005. Food Processing Technology: Principles and Practice. CRC Press, Woodhead Publishing Ltd.
2. Girdhari Lal, Siddappa G S and Tandon G L. 1967. Preservation of Fruits and Vegetables. Indian Council of Agricultural Research, New Delhi.
3. Kureel M K. 2020. Postharvest Management and Value Addition of Fruits and Vegetables. Bio- Green Books.
4. Potter Norman N. 2013. Food Science. Springer Science and Business Media.
5. Srivastava R P and Kumar Sanjeev. 2019. Fruit and Vegetable Preservation – Principles and Practices. CBS Publishers and Distributors Pvt Ltd.

SEMESTER VII

ELECTIVE CORSES

FRUIT SCIENCE

HORT – 401 Production Technology of Tropical Fruit crops 3 (2+1)

Objectives

1. To teach students origin, systematics, genetic resources, botany and production of tropical fruit crops
2. To impart adequate knowledge and skill to the students for commercial cultivation of tropical fruit crops

Theory

Importance, scope and commercial importance of tropical fruits. Distribution of tropical zones in the world and India. Origin, systematics, distribution, genetic resources, and eco-physiological requirements. Major species, commercial varieties and rootstocks. Propagation, planting, training and pruning. Nutrient and water management. crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques. Physiological disorders, major pests and diseases and their management. Industrial and export potential, Agri. Export Zones (AEZ) and industrial support. Fruit crops- mango, papaya, pineapple, banana, avocado, sapota, guava, jackfruit, tamarind,

annonas and minor fruits of tropics viz. carambola, mangosteen, pashion fruit, bilimbi, rambutan, longan and durian.

Practical

Description and identification of species and varieties of tropical fruits. Propagation and nursery management of tropical fruit crops. Leaf sampling and nutrient analysis. Rejuvenation of old and unproductive trees. Identification and management of nutritional disorders, insect-pest and diseases. Maturity standards, harvesting, grading, packaging and storage. Visit to commercial orchards.

Suggested Readings

1. Bartholomew DP, Paull RE and Rohrbach KG. 2002. The Pineapple: Botany, Production, and Uses. CAB International.
2. Bose T K and Parthasarathy V A. 2022. Fruits: Tropical and Subtropical. Vol 14th edn. Daya Publishing House, New Delhi.
3. Chattopadhyay T K. 2013. A Textbook on Pomology Vol I-II. Kalyani Publications. New Delhi.
4. ICAR. 2019. Handbook of Horticulture (Vol I and II). ICAR Publications, New Delhi.
5. Mitra SK. 2021. Guava: Botany, Production and Uses. CAB International.
6. Paull R E and Duarte O. 2011. Tropical Fruits (Vol. 1&2). CAB International.
7. Robinson JC and Sauco VG. 2010. Bananas and Plantains. CAB International.

HORT – 402 Production Technology of Sub tropical and temperate Fruit crops 3 (2+1)

Objectives

1. To familiarize the students about cultural and management practices of fruit crops
2. To impart a comprehensive knowledge and skills on quality production of fruit crops

Theory

Importance, scope and commercial importance of sub-tropical and temperate fruits. Distribution of sub-tropical and temperate zones in the world and India. Origin, systematics, distribution, genetic resources, and eco-physiological requirements. Major species, commercial varieties and rootstocks. Propagation, planting and HDP, training and pruning and orchard floor management. Nutrient and water management, flowering and fruit set, compatibility, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques. Physiological disorders, major pests and diseases and their management. Industrial and export potential, Agri. Export Zones (AEZ) and industrial support. Fruit crops- citrus, grapes, pomegranate, litchi, loquat, grapes, litchi, pomegranate, apple, pear, peach, plum, apricot, cherries, berries, persimmon, kiwifruit, walnut, almond, pecan nut, hazelnut, chestnut, strawberry.

Practical

Description and identification of varieties based on flower and fruit morphology of subtropical and temperate fruits. Canopy management. Selection of site and planting system, Mulching, Manure and fertilizer application including bio-fertilizers in fruit

crops. Preparation and application of growth regulators. Crop regulation, maturity indices, ripening of fruits, grading and packaging. Production economics of sub-tropical and temperate fruits. Visit to commercial orchards and
diagnosis of maladies.

Suggested Readings

1. Chadha KL and Shikhamany SD 1999. The Grape - Improvement, Production and Post-Harvest Management. Malhotra Book Depot, New Delhi.
2. Chattopadhyay T K. 2013. Text book on Pomology (Temperate Fruits), Volume IV. Kalyani Publishers, New Delhi.
3. Chattopadhyay T K. 2013. Text book on Pomology (Sub Tropical Fruits), Volume III. Kalyani Publishers, New Delhi.
4. Dhillon WS. 2013. Fruit Production in India. Narendra Publishing House, New Delhi.
5. Jackson D. Thiele G, Looney N E and Morley-Bunker M. 2011. Temperate and Subtropical Fruit Production. CAB International.
6. ICAR. 2019. Handbook of Horticulture (Vol I and II). ICAR Publications, New Delhi.
7. Sandhu S and Gill B S. 2013. Physiological disorders of fruit crops. NIPA, New Delhi.
8. Sharma R R and Krishna H. 2018. Textbook of temperate fruits. CBS Publishers and Distributors Pvt. Ltd., New Delhi.

HORT – 403 Breeding of Fruit crops 3 (2+1)

Objectives

1. To provide knowledge about the breeding objectives and methods of fruit breeding in a prescribed manner
2. To familiarize students with latest principles and practices of crop improvement in different fruit crops

Theory

Fruit breeding-history, importance in fruit production; Major problems in fruit breeding; Plant genetic resources, their conservation and utilization in fruit crops; Breeding objectives for improvement of commercial fruits (mango, citrus, guava, banana, grapes, strawberry, litchi, sapota, pomegranate, pineapple, papaya, apple, pear, peach, plum, cherry, kiwifruit, walnut, apricot, plantation crops-coconut, cocoa, tea, arecanut, coffee), their distribution, domestication and adaptation; Incompatibility, sterility, parthenocarpy and apomixes; Breeding methods-introduction, colonal selection, hybridization, mutation breeding, polyploid manipulation; Rootstock breedi and improvement of quality traits; Breeding for insect-pest and disease resistance and abiotic stresses; Biotechnological interventions in fruit crop improvement.

Practical

Tools and equipment of use in fruit breeding; Studies on bearing habits and flower structure; in-vitro pollen germination test and determination of pollen viability; Methods of emasculation and pollination; Hybrid seed collection, extraction and storage; hybrid seed germination; Raising and evaluation of segregating populations;

Induction of mutations through use of physical/chemical mutagens; Polyploidy manipulation; Hand on practice of Emasculation and pollination in major crops of the region.

Suggested Readings

1. Badenes, M. L. and Byrne, D. H. 2012. Fruit Breeding. Springer Science, New York.
2. Dinesh, M.R. and Sankaran, M. 2022. Fruit Breeding and Genetics, New India publishing Agency, New Delhi
3. Kumar, N. 2014. Breeding of Horticultural Crops: Principles and Practices. NIPA, New Delhi.
4. Ray. PK. 2002. Breeding Tropical and Subtropical Fruits. Narosa Publ. House, N. Delhi.
5. Ghosh, S. N., Verma, M. K. and Thakur, A. 2018. Temperate Fruit Crop Breeding: domestication to Cultivar Development. NIPA, New Delhi.

HORT – 404 Canopy management in Fruit crops 3 (2+1)

Objectives

1. To provide knowledge about manipulation of plant growth and development by employing different training and pruning procedures
2. To familiarize student with scientific principles of tree growth, physiology and understanding of tree response to various pruning cuts.

Theory

Introduction and importance of canopy management, objectives of canopy management, importance and factors affecting canopy development. Canopy types, tree architecture and different conventional and trellis training systems. Canopy manipulation for optimum utilization of light and its interception. Dwarfing physiology and high-density planting. Physical manipulation and growth regulation: Canopy management through rootstock and scion. Effect of thinning and heading cuts on branch growth. Canopy management through plant growth regulators, training and pruning and management practices. Canopy development and management in relation to growth, flowering, fruiting and fruit quality in different deciduous and evergreen fruits.

Practical

Study of different types of canopies, training of plants for different canopy types, Canopy development through pruning, study of different trellis training systems, development of effective canopy with support system, study on effect of different canopy types on production and quality of fruits understanding bearing behaviour and canopy management in different fruits, use of plant growth regulators, effect of pruning on light interception and fruit quality. Canopy management practices in different deciduous and evergreen fruits.

Suggested Readings

1. Bakshi JC, Uppal DK and Khajuria HN. 1988. The pruning of fruit trees and vines. Kalyani Publishers, New Delhi.

2. Chadha KL and Shikhamany SD.1999.The Grape: improvement, production and post-harvest management Malhotra Publishing House, Delhi.
3. Iyer CPA and Kurian R M. 2006. High density planting in tropical fruits: Principles and Practices. IBDC Publishers, New Delhi.
4. Pradeep Kumar, T. 2008. Management of horticultural crops. NIPA, New Delhi.
5. Singh G. 2010. Practical manual on canopy management in fruit crops. Dept. of Agriculture and Co-operation, Ministry of Agriculture (GoI), New Delhi.
6. Srivastava K K. 2012. Canopy management in fruits. ICAR, New Delhi.

HORT – 405 Biotechnological Approaches and Micro propagation in Fruit crops 3 (2+1)

Objectives

1. To provide knowledge about the biotechnological interventions and micropropagation methods in a prescribed manner
2. To familiarize students with biotechnological tools in fruit crops to enhance yield, biotic and abiotic stress management and improved quality traits to a considerable extent

Theory

Introduction, history and basic principles of biotechnology; Physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture; *In vitro* culture and hardening: callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; Hardening and ex vitro establishment of tissue cultured plants; Transgenics and Gene Technologies; Somatic cell hybridization, construction and identification of somatic hybrids and cybrids, wide hybridization; *In-vitro* pollination and fertilization, haploids, in vitro mutation, artificial seeds, cryopreservation: *In- vitro* selection for biotic and abiotic stress; use of molecular markers and genomics; Gene silencing, gene tagging, gene editing, achievements of biotechnology in fruit crops.

Practical

An exposure to low cost, commercially operated and privately-owned tissue culture laboratories; Tasks include preparing media, inoculating explants for clonal multiplication, inducing and culturing callus, and regenerating plantlets from callus; Methods for sub-culturing on anther, ovule, embryo culture, and somaclonal variation; *In vitro* mutant selection against abiotic stress; Protoplast culture and fusion process. Development of large-scale mass multiplication; Project development for the establishment of a commercial tissue culture laboratory.

Suggested readings

1. Bajaj YPS. 1989. Biotechnology in agriculture and forestry. Vol. V, Fruits. Springer, USA.
2. Brown T A. 2001. Gene cloning and DNA analysis and introduction. Blackwell Publishing, USA.
3. Chahal GS and Gosal SS. 2010. Principles and procedures of plant breeding: biotechnological and conventional approaches. Narosa, New Delhi.

4. Keshavachandran R, Nazeem PA, Girija D, John PS and Peter KV. 2007. Recent Trends in Biotechnology of Horticultural Crops. Vols. I, II. NIPA, New Delhi.
5. Miglani GS. 2016. Genetic Engineering – principles, procedures and consequences. Narosa Publishing House, New Delhi.

HORT – 406 Production Technology of Arid Fruit Crops 3 (2+1)

Objectives

1. To impart basic knowledge about the arid fruit crops
2. To familiarize students with the latest developments and trends in production technology of important arid fruit crops

Theory

Importance, scope and limitations of arid and semi-arid zones, Distribution of Agro-climatic arid and semi-arid zones, soil and water conservation methods-terraces, contour bunds etc. Methods of control and impounding of run-off water - farm ponds, trenches, macro catch pits etc. *In-situ* water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, anti transpirants, growth regulators, etc. micro systems of irrigation etc. Characteristic feature of arid fruit crops, bearing habit, flowering and fruit set, improved varieties, planting techniques, propagation, canopy management, nutrient and weed management, Special production problems, insect-pests, diseases and their control measures, Postharvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops: ber, aonla, pomegranate, jamun, bael, date palm, phalsa, fig, custard apple, karonda, prickly pear, lasora, sea buckthorn, pistachio and wood apple

Practical

Identification of various arid fruit crops, Planning and layout of orchards, propagation methods in arid fruit crops, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, leaf sampling and nutrient analysis, preparation and application of growth regulators, layout of different irrigation systems, Identification and management of nutritional disorders, insect pest and disease management, maturity standards, harvesting, grading, packaging and storage.

Suggested Readings

1. Chattopadhyay T K 2013. A Textbook on Pomology Vol I-IV. Kalyani Publications. New Delhi.
2. Hiwale S 2015. Sustainable Horticulture in Semiarid Drylands. Springer.
3. ICAR 2019. Handbook of Horticulture (Vol I and II). ICAR Publications. New Delhi.
4. Krishna H and Sharma R R 2017. Fruit Production- Minor Fruits. Daya Publishing House, Delhi.
5. Peter K V 2010. Underutilized and Underexploited Horticultural Crops. NIPA, New Delhi.
6. Saroj P L and Awasthi O P 2005. Advances in Arid Horticulture, Vol II: Production Technology of Arid and Semiarid Fruits. IBDC, Lucknow.
7. Sontakke M B 2014. Production and Management of Fruit Crops in Arid/Drylands. Agrotech Publishing Academy, Udaipur (Rajasthan).

HORT – 407 Postharvest Management of Fruit crops 2 (1+1)

Objectives

1. To provide knowledge about various physico-chemical changes occurring during postharvest life of fruits
2. To familiarize students with various techniques to minimize postharvest losses and maintain the postharvest quality of fruits

Theory

Importance and scope. Maturity indices, harvesting practices and grading. Influence of pre-harvest practices. Physiology and biochemistry of fruit ripening, ethylene evolution and its management. Pre-cooling. Factors leading to post-harvest losses. Treatments prior to transportation viz. chlorination, waxing, chemicals, natural plant products, hot-water, vapour heat treatment, sulphur fumigation and irradiation. Fruit packaging and transport. Methods of storage.

Practical

Analyzing maturity stages of commercially important fruit crops, harvesting methods, precooling methods, grading. Components of cold and ripening chambers. Ripening of fruits. Preharvest and post-harvest application of growth substances, fungicides, nutrients, waxes and hot water treatments. Improved packing and storage of important horticultural commodities, Physiological loss in weight of fruits. Estimation of quality characteristics viz; TSS, titratable acidity, firmness, Vitamin C, sugars in stored fruits.

Suggested Readings

1. Kader A A. 2002. Postharvest technology of horticultural crops. 3rd edn, University of California, Agricultural and Natural Resources.
2. Wills R, McGlasson B, Graham D and Joyce DC. 2007. An introduction to the physiology and handling of Fruits, Vegetables and ornamentals, CAB International
3. Saraswathy S, Preethi TL, Balasubramanyam S, Suresh J, Revathy N and Nararajan S. 2010. Postharvest management of horticultural crops. Agrobios publication, Jodhpur.
4. Verma LR and Joshi VK. 2000. Postharvest technology of fruits and vegetables. Vol I and II

VEGETABLE SCIENCE

HORT – 408 Production Technology of Warm Season Vegetable Crops 3 (2+1)

Objectives

To impart knowledge and skills for production of warm season vegetable crops

Theory

Introduction, nutritional value, origin, botany and taxonomy, important countries and states growing vegetables along with area, climate and soil requirements, commercial varieties/hybrids, sowing/ transplanting time, seed rate, seed treatment, nutritional

and irrigation requirements, chemical weed control, mulching, physiological disorders, harvesting techniques, postharvest management, plant protection measures and seed production of warm season vegetable crops i.e. solanaceous crops, okra, cucurbitaceous crops, cowpea, sweet potato, cluster beans, amaranth, basella, moringa, tapioca. Poly-house, net- house and low tunnel technology for off-season production of summer vegetables

Practical

Seed extraction, sowing practices, nursery management, Use of growth regulators, grafting technique, water and nutrient management. Drip irrigation, fertigation, weed management and mulching. Identification of physiological disorders, pests, diseases and nutrient deficiencies. Study of maturity indices. Forcing techniques for raising summer vegetables. Visit to vegetable nursery unit/ protected cultivation unit.

Suggested readings

1. Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. Vegetable crops. Vols. I-III. Naya Udyog.
2. Dhaliwal M S. 2017. Handbook of Vegetable Crops. Kalyani publishers, Ludhiana
3. Hazra P. 2016. Vegetable science. 2nd Ed, Kalyani publishers, Ludhiana.
4. Hazra P. 2019. Vegetable production and technology. NIPA, New Delhi.
5. ICAR. 2002. Hand Book of Horticulture. ICAR.
6. Thamburaj S and Singh N (Eds). 2004. Vegetables, tuber crops and spices. ICAR.

HORT – 409 Production Technology of Cool Season Vegetable crops 3 (2+1)

Objectives

To impart knowledge and skills for production of cool season vegetable crops

Theory

Introduction, nutritional value, origin, botany and taxonomy, important countries and states growing vegetables along with area, climate and soil requirements, commercial varieties/hybrids evolved by private and public sector, sowing/ transplanting time, seed rate and seed treatment, nutritional and irrigation requirements, chemical weed control, mulching, physiological disorders, harvesting techniques, postharvest management, plant protection measures and seed production of potato, cole crops; cabbage, cauliflower, knolkhol, broccoli, brussels' sprout, chinese cabbage, root crops; carrot, radish, turnip, beet root, bulb crops; onion and garlic, peas and beans, green leafy cool season vegetables.

Practical

Seed extraction, sowing practices, nursery management, Use of growth regulators, grafting technique, water and nutrient management. Drip irrigation, fertigation, weed management and mulching. Identification of physiological disorders, pests, diseases and nutrient deficiencies. Study of maturity indices. Forcing techniques for raising cool season vegetables. Visit to vegetable nursery unit/ protected cultivation unit. Layout of kitchen garden.

Suggested Readings

1. Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. Vegetable crops. Vols. I-III. Naya Udyog.
2. Dhaliwal M S. 2017. Handbook of Vegetable Crops. Kalyani publishers, Ludhiana
3. Hazra P. 2016. Vegetable science. 2nd edn, Kalyani publishers, Ludhiana.
4. Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi.
5. ICAR. 2002. Hand Book of Horticulture. ICAR.
6. Thamburaj S and Singh N (Eds). 2004. Vegetables, tuber crops and spices. ICAR.

HORT – 410 Production Technology of Tuber crops 3 (2+1)

Objectives

To impart knowledge and skill for production of tuber crops and their management

Theory

Origin, area, production, economic importance and export potential of tropical, sub-tropical and temperate tuber crops; description of varieties and hybrids. Climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems. Harvesting practices yield; economic of cultivation. Postharvest handling and storage, marketing. Crops to be covered potato, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke, horse radish, coleus and yam bean and other under exploited tuber crops.

Practical

Identification and description of potato and tropical, sub-tropical and temperate tuber crops; planting systems and practices; field preparation and sowing/planting. Top dressing of fertilizers and interculture and use of herbicides and growth regulators; identification of nutrient deficiencies, physiological disorders; harvest indices and maturity standards, postharvest handling and storage, marketing. Seed collection, working out cost of cultivation.

Suggested Readings

1. Dhaliwal M S. 2008.Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana 2. ICAR. 2002. Hand Book of Horticulture. ICAR.
2. Thamburaj S. 2014. Text book of vegetable, tuber crops and Spices. ICAR, New Delhi.
3. Umashankar. 2008. Indian Vegetables. Anmol Publications. Pvt. Ltd., New Delhi.

HORT – 411 Breeding of Vegetable crops 3 (2+1)

Objectives

1. To make students well verse with the plant genetic resources and their utilization in improvement of vegetable crops
2. To impart knowledge and skill regarding breeding procedures of self-pollinated, often cross pollinated, cross-pollinated and vegetatively propagated vegetable crops

Theory

Definition and history of vegetable breeding. Origin, distribution, wild relatives and breeding objective of different vegetable crops viz. tomato, brinjal, chilli, muskmelon, watermelon, cucumber, bitter gourd, pumpkin, squashes, onion, garlic, carrot, radish, cauliflower, cabbage, pea, okra and potato. Plant genetic resources, their utilization and conservation. Breeding procedures of selfpollinated, often cross pollinated, cross-pollinated and vegetatively propagated vegetable crops. Conventional and modern techniques for improvement of vegetable crops. Breeding for biotic, abiotic stress tolerance and quality in vegetable crops. Genetic mechanisms for exploitation of heterosis in vegetable crops.

Practical

Study of inflorescence and flower structures. Practice for emasculation and artificial pollination. Distinguished morphological characteristics of released varieties/hybrids. Layout of field experiments. Estimation of heterosis. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods. Visit to vegetable seed production field.

Suggested readings

1. Allard RW. 1960. Principle of plant breeding. John Willey and Sons, USA.
2. Kalloo G. 1988. Vegetable breeding (Vol. I, II, III). CRC Press, Fl, USA.
3. Kole CR. 2007. Genome mapping and molecular breeding in plants-vegetables. Springer, USA.
4. Peter KV and Pradeep Kumar T. 1998. Genetics and breeding of vegetables. ICAR, New Delhi, p. 488.
5. Prohens J and Nuez F. 2007. Handbook of plant breeding-vegetables (Vol I and II). Springer, USA.
6. Ram H H. 2019.Vegetable Breeding: Principles and Practices. Kalyani Publishers.
7. Singh BD. 2007. Plant breeding- principles and methods. 8th edn. Kalyani Publishers, New Delhi.
8. Singh Ram J. 2007. Genetic resources, chromosome engineering, and crop improvement vegetable crops (Vol. 3). CRC Press, Fl, USA.
9. Swarup V. 2016.Vegetable Science and Technology in India. Kalyani Publishers.

HORT – 412 Biotechnological Approaches and Micropropagation in Vegetable crops 3 (2+1)

Objectives

To educate students about latest biotechnical advancements in vegetables

Theory

Concepts and applications of plant biotechnology. Introduction to recombinant DNA methods: physical, chemical and Agrobacterium mediated gene transfer methods; Transgenics and its importance in crop improvement; PCR techniques and its applications; DNA markers and their application - RFLP, RAPD, AFLP, CAPS, SSR etc. Marker Assisted Breeding in crop improvement; Biotechnology regulations. Plant Cell and Tissue Culture - organ culture, embryo culture, cell suspension culture,

protoplast culture, callus culture, anther culture, pollen culture, ovule culture and their applications; Micro-propagation methods; organogenesis and embryogenesis, Synthetic seeds and their significance; Embryo rescue and its significance. Somatic hybridization and cybrids. Soma-clonal variation and its use in crop improvement. Cryo-preservation. Application of *in-vitro* techniques.

Practical

Preparation of solution, pH and buffers. Sterilization techniques. Composition of various tissue culture media and preparation of stock solutions for MS nutrient medium. Callus induction from various explants and plant regeneration. Micro-propagation, hardening and acclimatization. Demonstration on isolation of DNA and PCR technique. Demonstration of gel electrophoresis techniques and DNA finger printing.

Suggested Readings

1. Bajaj YPS (Ed.). 1987. Biotechnology in agriculture and forestry. Vol. XIX. Hitech and Micropropagation. Springer.
2. Chadha KL, Ravindran PN and Sahijram L (Eds). 2000. Biotechnology of horticulture and plantation crops. Malhotra Publ. House.
3. Debnath M. 2005. Tools and techniques of biotechnology. Pointer publication, New Delhi. Horticultural Sciences–Vegetable Science
4. Keshavachandran R. 2007. Recent trends in biotechnology of horticultural crops. New India Publ. Agency.
5. Keshavachandran R and Peter KV. 2008. Plant biotechnology; tissue culture and gene transfer. Orient and Longman, USA.
6. Keshavachandran R. 2007. Recent trends in biotechnology of horticultural crops. New-India Publication Agency, New Delhi.
7. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK and Mohanadas S. 2001. Biotechnology of horticultural crops. Vols. I-III. Naya Prokash. Pierik RLM. 1987. In-vitro culture of higher plants. Martinus Nijhoff Publ.
8. Prasad S. 1999. Impact of plant biotechnology on horticulture. 2nd edn. Agro Botanica.
9. Rout GR and Peter KV. 2018. Genetic engineering of horticultural crops. Academic Press Elsevier, USA.
10. Sharma R. 2000. Plant tissue culture. Campus Books.
11. Singh BD. 2010. Biotechnology- expanding horizons. Kalyani Publishers, New Delhi.
12. Vasil TK, Vasi M, While DNR and Bery HR. 1979. Somatic hybridization and genetic manipulation in plants, plant regulation and world agriculture. Planum Press.

HORT – 413 Postharvest Management of Vegetable Crops 3 (2+1)

Objectives

To understand pre- and post-harvest factors responsible for deterioration in vegetable crops

Theory

Determination of maturity in different vegetable crops, assessment of post-harvest losses, preharvest methods and practices affecting post-harvest shelf life of vegetables, mechanized harvesting of vegetables, pre-cooling of vegetables using different techniques, post-harvest chemical and nonchemical treatments to enhance shelf life, sorting and grading for packaging, ripening of vegetables, packaging of vegetables

including latest techniques like MAP, storage of vegetables including latest techniques like CA storage, food safety and quality, non-destructive methods of quality analysis, quality of raw material for processing, transportation and destination handling, marketing, treatments before shipment and storage, fresh-cut vegetables.

Practical

Practices in judging the maturity of vegetables, harvesting methods and tools. Methods used for pre-cooling and their efficiency measurements. Post-harvest chemical treatments to extend shelf life. Sorting and grading methods. Ripening techniques used in climacteric vegetables. Traditional and latest safe storage techniques. Respiration measurements in harvested produce. Field visit to post-harvest and processing industry.

Suggested Readings

1. Chadha KL and Pareek OP. 1996. Advances in horticulture. Vol. IV. Malhotra Publ. House.
2. Chattopadhyay SK. 2007. Handling, transportation and storage of fruit and vegetables. Gene Tech books, New Delhi.
3. Haid NF and Salunkhe SK. 1997. Postharvest physiology and handling of fruits and vegetables. Grenada Publ.
4. Mitra SK. 1997. Postharvest physiology and storage of tropical and sub-tropical fruits. CABI.
5. Paliyath G, Murr DP, Handa AK and Lurie S. 2008. Postharvest biology and technology of Fruits, vegetables and flowers. Wiley-Blackwell, ISBN: 9780813804088.
6. Ranganna S. 1997. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw-Hill.
7. Stawley JK. 1998. Postharvest physiology of perishable plant products. CBS publishers.
8. Sudheer KP and Indira V. 2007. Postharvest technology of horticultural crops. New India Publ. Agency.
9. Thompson AK (Ed.). 2014. Fruit and vegetables: harvesting, handling and storage (Vol. 1 and 2) Blackwell Publishing Ltd, Oxford, UK. ISBN: 9781118654040.
10. Verma LR and Joshi VK. 2000. Postharvest technology of fruits and vegetables: handling, processing, fermentation and waste management. Indus Publishing Company, New Delhi, India. ISBN 8173871086.
11. Willis R, McGlassen WB, Graham D and Joyce D. 1998. Postharvest: An introduction to the physiology and handling of fruits, vegetables and ornamentals. CABI.
12. Wills RBH and Golding J. 2016. Postharvest: an introduction to the physiology and handling of fruit and vegetables, CABI Publishing, ISBN 9781786391483.
13. Wills RBH and Golding J. 2017. Advances in postharvest fruit and vegetable technology, CRC Press, ISBN 9781138894051

HORT – 414 Protected Cultivation of Vegetable crops 2 (1+1)

Objectives

To provide technical know-how to students for raising vegetables under protected structures

Theory

Protected cultivation- importance, scope and constraints, status of protected cultivation in India and world. Soil/substrate preparation and management. Classification and types of protected structures. Irrigation and fertigation management. Propagation and production of quality planting material of horticultural

crops. Greenhouse cultivation of important horticultural crops viz., tomato, bell pepper, cucumber, lettuce, brinjal. Off season production of vegetables. Hydroponics, aeroponics system of cultivation, Insect pest and disease management. Use of protected structures for seed production; Economics of greenhouse crop production.

Practical

Identification of different protected structures, Use of pro-trays in quality planting material production, Identification of different growing media/ substrates, Raising of seedlings and saplings under protected cultivation, Bed preparation, planting and intercultural operations for crop production, Estimation and management of soil EC, Estimation and management of pH in media/substrates, Scheduling of irrigation in different horticultural crops, Fertilizer management through drip irrigation, Control of disease and insect pests in protected structures, fumigation techniques.
Visit to commercial protected cultivation units.

Suggested Readings

1. Chandra S and Som V. 2000. Cultivating vegetables in green house. Indian Horticulture 45:17-18.
2. Parvatha RP. 2016. Sustainable crop protection under protected cultivation. E-Book Springer.
3. Prasad S and Kumar U. 2005. Greenhouse management for horticultural crops. 2nd edn. A Grobios.
4. Singh B. 2005. Protected cultivation of vegetable crops. Kalyani publishers, New Delhi.
5. Singh DK and Peter KV. 2014. Protected cultivation of horticultural crops (1st edn). New India Publishing Agency, New Delhi.
6. Singh S, Singh B and Sabir N. 2014. Advances in protected cultivation. New India Publishing Agency, New Delhi.
7. Tiwari GN. 2003. Green house technology for controlled environment. Narosa publ. house.

FLORICULTURE AND LANDSCAPING

HORT – 415 Turf Management 2 (1+1)

Objectives

1. To impart hands-on training on practical aspects of turf management practices
2. To impart entrepreneurial skills in turf establishment

Theory

History, present status and prospects of turf industry; basic requirements, site selection and evaluation, concepts of quality of soil pertaining to turf grass establishment, criteria for evaluation of turf quality. Types, species, varieties, important breeders, grasses for different locations and conditions and their compatible groupings as per climatic conditions; Turfing for roof gardens. Turf establishment methods such as seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, instant turfing (portable), hydro-seeding, Turf management – Irrigation, drainage, nutrition, special practices like aerating, rolling, coring, dethatching, verti-cutting, soil topdressing, use of plant growth regulators and micronutrients, Turf

mowing – mowing equipment, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs, standards for turf, use of recycled water etc., Making of different sports arenas: Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, residential and public parks, turfing of Govt. and Corporate office gardens, turf colourants.

Practical

Identification of turf grasses and turf machinery, Soil preparation, turf establishment methods, provision of drainage, Layout of macro and micro irrigation systems, Water and nutrient management, Special practices – mowing, raking, rolling, soil top dressing, weed management, Project preparation for turf establishment, Visit to parks and golf courses, corporate, Govt. organizations, Rejuvenation of lawns, Turf economics.

Suggested Readings

1. Jankiram, T, Namita and Jain Ritu. Introduction to Turfgrasses. 2015. 1st edn. Westville publishing house.
2. Nick E. 2016. Christians Fundamentals of Turfgrass Management. 5th edn, Aaron J. Patton, Quincy D. Law. Published by Wiley
3. Tiwari A K, Singh, K P, Shephalika Amrapali, Girish, K S and Singh Premjit. 2015. Lawn Management. ICAR-Directorate of Floricultural Research, Pune-411005 (Maharashtra), India 1-48.

HORT – 416 Protected Cultivation of Flower Crops 3 (2+1)

Objectives

1. To enable regulation of flowering under protected cultivation
2. To impart skills in formulating the project on protected cultivation of flower crops

Theory

Prospects and types of protected structures: Prospects of protected floriculture in India; Types of protected structures – Glasshouse/polyhouse, shade net houses, mist chambers, lath houses, orchidarium, fernery, rain shelters etc. Principles of designing and erection of protected structures; Low cost/Medium cost/High-cost structures; Structural components; Suitable flower and foliage plants for protected cultivation. Microclimate management and manipulation of temperature, light, humidity, air and CO2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation, containers and substrates, media, soil decontamination, layout of drip and fertigation system, water and nutrient management, IPM and IDM, Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation. Automation in greenhouses, sensors, solar greenhouses and retractable greenhouses, Export standards, MDH guidelines for erection of protected structure, APEDA regulations for export. Crops: Rose, Chrysanthemum, Carnation, Gerbera, Orchids, Anthuriums, Lilium, Alstromeria, etc.

Practical

Study of various protected structures, Design, layout and erection of different types of structures, Practices in preparatory operations, growing media, soil decontamination techniques, Microclimate management, Practices in drip and fertigation techniques, special horticultural practices, Determination of harvest indices and harvesting methods, Postharvest handling, packing methods, Economics of cultivation, Project preparation, Project Financing guidelines, Visit to commercial greenhouses.

Suggested Readings

1. Tyagi S and Sahay S 2020. Protected cultivation of flowers 2020 NIPA, New Delhi.
2. Singh Mahesh Chand and Sharma, K K. 2024. Protected Cultivation: Structural design, crop management, modelling and automation. CRC Press.

HORT – 417 Value Addition in Floriculture 3 (2+1)

Objectives

1. To study different methods of value addition like drying, flower arrangements, oil extraction, etc.
2. To prepare value added products from flower crops

Theory

Scope and prospects of value addition, Types of value-added products, techniques of value addition including tinting. Value addition in loose flowers and product development- Gulkhand, floral tea, rose oil, rose water, Pankhuri, floral dyes, rose sherbet, floral ice creams, sweets, etc. Flower arrangement, styles, ikebana schools (ikenobo, ohara, sogetsu etc), Ikebana- moribana, nagiere, contemporary style. Dry flowers– Identification and selection of flowers and plant parts; tips for collecting dry flower making, selection of stages for picking of flowers for drying, Techniques in dry flower making – Drying, glycerising, bleaching, dyeing, embedding, pressing; Designing and arrangement – dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; petal embedded handmade papers. Post drying management including moisture, pests and molds. Essential oils; Selection of species and varieties (including nonconventional species), extraction methods, Packing and storage, Aromatherapy. Types of pigments, carotenoids, anthocyanins, chlorophyll, betalains; Significance of natural pigments as nutraceuticals, Extraction methods and applications in food, pharmaceutical and poultry industries. Synthetic and Natural dyes, dying techniques, colour retention.

Practical

Practices in preparation of different type of flower arrangements including bouquets, buttonholes, flower baskets, corsages, floral wreaths, garlands with fresh flowers, Techniques in flower arrangement and floral decoration, Identification of plants for dry flower making, Practices in dry flower making; Preparation of dry flower baskets, bouquets, potpourri, wall hangings, button holes, greeting cards, wreaths, etc. Essential oil extraction units, Extraction of pigments, Visit to dry flower units, Economics of value-added products.

Suggested Readings

1. De LC. 2019. Value Addition in Flowers and Orchids- New India Publishing Agency.
2. Gupta Sachi, Pathak Sanjay and Yadav Atul. 2019. Advances and value addition in flower crops. Weser Books.

HORT – 418 Breeding of Ornamental crops 3 (2+1)

Objectives

1. To teach the students crop specific breeding
2. To teach the students about the varieties evolved in flower crops through various methods and institutions

Theory

Origin, evolution, distribution, introduction, domestication and conservation of ornamental crops. Unit II: Introduction and initiatives in IPR and PBR of ornamental crops. Breeding objectives, reproductive barriers (Male sterility, incompatibility) in major ornamental crops. Inheritance of important traits, Genetic mechanisms associated with flower colour, size, form, doubleness, fragrance, plant architecture, post-harvest life, abiotic and biotic stress tolerance/ resistance. Breeding methods suitable for sexually, asexually propagated flower crops, self- and cross- pollinated crops pedigree selection, backcross, clonal selection, polyploidy and mutation breeding, heterosis and F1 hybrids. Role of biotechnology in improvement of flower crops including somaclonal variation, in vitro mutagenesis, genetic engineering, molecular markers etc., Crops- 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, tecoma, kalanchoe etc.

Practical

Floral biology of important ornamental crops, Cytology. Selfing and crossing procedures for important ornamental crops. Evaluation of hybrid progenies. Induction of mutants through physical and chemical mutagens. *In vitro* selection, genetic engineering. Induction of polyploidy. DUS testing.

Suggested Readings

1. De LC. 2019. Ornamental Crop Breeding. Aavishkar Publishers and Distributors, Jaipur, Rajasthan.
2. Singh BD. 2006. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.

HORT – 419 Principles of Landscape Architecture 3 (1+2)

Objectives

1. To familiarize students with basics of Auto-CAD software
2. To impart skills in preparation of garden designs

Theory

Historical Importance of Indian gardens, Gardens of ancient world, Definitions, Famous gardens of India and abroad, formal, informal, free style and wild gardens, basic themes of gardens viz. circular, rectangular and diagonal themes, Steps in preparation of garden design. Use of Auto CAD in designing gardens. Factors affecting landscape design viz. initial approach, view, human choice, simplicity, topography etc., Principles of Landscape gardens viz. Axis, rhythm, balance, texture, form, mass effect, focal point, mobility, emphasis, unity and harmony etc. Elements of landscape gardens. Bio-aesthetic planning, definition, objectives, Planning and designing of home gardens, colonies, countryside planning, urban landscape, Development of institutional gardens, planning and planting of avenues, beautifying schools, railway stations, factories, bus stands, air ports corporate buildings, river banks, play grounds.

Practical

Study of gardens, tools and implements. Use of drawing equipment, graphic symbols and notations in landscaping designing, Study and designing of different styles of gardens, Study and designing of gardens based on different themes, Designing gardens using Auto-cad, Designing gardens for home, traffic islands, schools and colleges, public buildings, factories, railway stations, air ports, religious places, play grounds, corporate buildings/ malls. Designing and planting of avenues for state and National highways, Design and establishment of Japanese, English and Mughal gardens. Visit to public, institutional and botanical gardens.

Suggested readings

1. Arora, J.S. 2010. Introductory Ornamental Horticulture. Kalyani Publishers. 6th edn, pp.230.
2. Randhawa, G. S. and Mukhopadhyay, A. 2001. Floriculture in India. Allied Publishers, pp 660.

HORT – 420 Commercial Floriculture and Landscaping 3 (2+1)

Objectives

1. To learn about production technology, propagation, and cultural practices and packaging and marketing of various flower crops
2. To learn generating the planting material and their practical use in different landscaping projects

Theory

Scope, importance and export potential of floriculture, environment factors influencing plant growth and flower production in cut flowers and cut greens. Production technology including varieties, propagation, soil, nutrition, disease and pests of important cut flowers. Post harvest handling, grading and packing cut flowers, pot and bedding plants. Flower seed production. Cost of production of commercially important flowers. History of gardening, characteristics of Hindu, Mughal, Japanese and English gardens. Principle groups of plants like trees, shrubs, climbers, shade loving plants,

ground covers, their analysis and use in landscape composition. Principles of art and landscaping. Preparation of landscape plans for homes, farm complexes, small parks and institutions. Development and maintenance of rock, water and terrace gardens. Bonsai and dish gardens, project formulation and evaluation.

Practical

Preparation of plans and laying out of gardens. Identification of planting material and commercial varieties of flowers. Seed collection, germination tests and storage. Harvesting and handling of cut flowers. Judging of flowers and pot plants. Visit to local nurseries and florist centers.

Suggested readings

1. Arora, J.S. 2010. Introductory Ornamental Horticulture. Kalyani Publishers. 6th edn, pp. 230.
2. Randhawa, G. S. and Mukhopadhyay, A. 2001. Floriculture in India. Allied Publishers. pp 660.

HORT – 421 Postharvest handling of Floriculture crops 3 (2+1)

Objectives

1. To teach the students about various factors leading to postharvest losses in flowers
2. To acquaint the students about various technologies (like conditioning, grading, storage, packaging etc) used in postharvest management of flowers
3. To provide hand on training to students for postharvest handling of commercial flowers

Theory

Importance of Postharvest Technology in Floricultural crops, Physiology of flowering in relation to photoperiodism, temperature and other environmental factor. Structural, biochemical, metabolic and hormonal changes during flower senescence. Factors affecting postharvest quality of flowers- pre harvest, harvest and postharvest. Causes of decline in post-harvest life of flowers. Floral preservatives - holding, pulsing and budding. Plant hormones and their role in postharvest management of flowers. Storage, its types and factors affecting storage. Grading of different flowers. Packaging – passive and active. Importance of cool chain in transportation of cut flowers. Physiological disorders of flowers. Latest approaches to improve postharvest life of flowers. Postharvest handling of commercial flowers- Rose, Chrysanthemum, Gladiolus, Lilium Tuberose and marigold.

Practical

Photoperiodism and vernalization in flowering. Membrane integrity and water relation during senescence. Harvest and postharvest factors affecting postharvest quality of flowers. Preparations of different solutions. Holding and pulsing solutions. Wet and dry storage. Grading of flowers. Types of packaging. Physiological disorders of flowers and their remedial measures. Postharvest handling of commercial flowers- Rose, Chrysanthemum, Gladiolus, Lilium Tuberose and marigold.

Suggested Readings

1. Bhattacharjee, SK and De, LC. 2004. Advances in Ornamental Horticulture Vol. V, Pointer publishers, Jaipur.
2. Bose, TK and Yadav, LP. 1989. Commercial Flowers. Naya Prokash, Kolkata.
3. Bose, TK, Maiti, RG, Dhua, RS and Das, P. 1999. Floriculture and Landscaping. Naya Prokash.
4. Larson, RA and Armitage, AM. 1992. Introduction of Floriculture. International Book Distributing Co., Lucknow, India.
5. Nowak, J and Rudnicki, RM. 1990. Postharvest handling and storage of cut flowers, florist greens, and potted plants. Timber Press, USA. pp. 210.