

Course Title: Crop Regulation in Ornamental Crops**Course Code: FLS 601****Credit Hours: (2+1)**

The course deals with the physiological and biochemical basis of crop regulation and programmed production of flower crops. The students need a thorough understanding on crop regulation to improve the profitability of growers

Theory**Block 1: Basis of crop regulation**

Unit I: Basis of flowering: Ecophysiological influences on growth and development of flower crops for flowering, Crop load and assimilate partitioning and distribution. Root and canopy regulation.

Unit II: Growth regulators: Study of plant growth regulators including biostimulants and polyamines in floriculture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants. Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, Plant architecture management for flower crops and ornamental plants, molecular approaches in crop growth regulation.

Block 2: Programming

Unit I: Growth regulation: Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, flower bud initiation, regulation of flowering, photo and thermo periodism, off season production, bulb forcing techniques.

Unit II: Programmed production: Programmed production of important flower crops like chrysanthemum, tulips, liliun, daffodils, poinsettia, kalanchoe, gypsophila

Practical

- Plant architecture studies in important flower crops
- Bioassay and isolation through chromatographic analysis for auxins, gibberellins, cytokinins, ABA
- Growth regulation during propagation, dormancy, flowering
- Photoperiod regulation in short day and long day crops
- Off season production in important crops
- Bulb forcing in bulbous ornamental crops
- Exposure visits.

Course Title: Postharvest Biology of Floricultural Crops**Course Code: FLS 602****Credit Hours: (2+1)**

The course deals with physiological, biochemical basis of senescence of flowers and the treatments and packaging methods to mitigate these processes for improving post-harvest life.

Theory**Block 1: Preharvest and post harvest physiology and biochemistry**

Unit I: Pre harvest physiology: Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and other biochemical changes, respiration, transpiration in important flower crops.

Unit II: Senescence: Physiology and biochemistry of flowering, enzymatic changes, Ethylene sensitivity, ethylene evolution and management, factors leading to post-harvest loss, pre-cooling. Petal senescence at molecular level, functional gene analysis for postharvest flower quality in important flower crops, etc.

Unit III: Pigments and secondary metabolites: Biosynthetic pathways of chlorophyll, xanthophyll, carotenoids, flavonoids and anthocyanins and betalains. Chemistry and

importance of secondary metabolites. Biochemistry and utilization for commercial products in important flower crops.

Block 2: Storage and packaging

Unit I: Storage of flowers: Treatments prior to shipment, viz., precooling, pulsing, impregnation, chemicals, Irradiation, biocontrol agents and natural plant products. Methods of storage: ventilated, refrigerated, Modified atmosphere, Controlled atmosphere storage, cool chain management, physical injuries and disorders in important flower crops.

Unit II: Packaging: Packing methods and transport, Smart technologies in packaging and storage, advanced tools like nanotechnology application for quality parameters and post harvest treatments for export in important flower crops, packaging standards, flower labels value chain in floriculture.

Unit III: Recent trends: Recent trends- extraction of bio-colours from flowers conventional as well as *in-vitro* methods and their value addition uses in food and textile industries. Molecular techniques for enhancing postharvest flower quality, transgenics in ornamental plants for enhanced postharvest life.

Unit IV: Dried ornamental crops: Post harvest handling of dried ornamental crops including packing, storage and shipment. Storage pest and mould problems in dried ornamental produce, colour retention, physiological and biochemical changes, etc.

Practical

- Improved packaging and storage of important flowers
- Physiological loss in weight of flowers, estimation of transpiration, respiration rate, ethylene release and study of vase life
- Extension in cut flower vase life using chemicals
- Estimation of quality characteristics in stored flowers
- Estimation of biochemical changes like enzymatic changes, lipids and electrolyte leakage
- Extraction of flower pigments – Chlorophyll, xanthophylls, carotenoids and anthocyanins
- Cold chain management – visit to cold storage, MA and CA storage units
- Project preparation

Course Title: Specialty Flowers, Fillers and Cut Greens

Course Code: FLS 603

Credit Hours: (1+1)

This course deals with introduction to specialty flowers, cut greens and fillers, ways to cultivate them and their post harvest handling and storage. The students need to be aware of these crops so that they could improve the profitability of growers.

Theory

Block 1: Scope

Unit I: Importance, national and international scenario: Introduction, present status, scope, importance and avenues for specialty flowers and cut greens.

Block 2: Avenues

Unit I: Specialty flowers: Cultivation practices of specialty flower crops like heliconia, red ginger, Bird of Paradise, Ornamental banana, ornamental curcuma, gingers, wax flower, kangaroo paw, limonium, rice flower, etc.

Unit II: Fillers: Cultivation practices of fillers like gypsophila, solidago, Mollucella, lupins, etc.

Unit III: Cut greens: Cultivation practices of cut greens like anthurium, ferns, asparagus, cycas, thuja, bottle brush, ornamental palms, zanado, dracaena, eucalyptus, ruscus, dianella, alpinia, etc.

Block 3: Trade and Marketing

Unit I: Post harvest management: Pre and post harvest factors influencing the vase life of the flowers and fillers, Post harvest management including pulsing, holding, packing, storing, forward and backward linkages, value chain management.

Unit II: Standards: Quality standards, Packaging standards, marketing and trade in important flower, filler and foliage crops.

Practical

- Identification of specialty flowers, fillers and cut greens
- Media and bed preparation for cultivation
- Propagation of important crops
- Integrated disease and pest management in important crops
- Post harvest handling of specialty flowers, fillers and cut greens
- Preparation of value added products from important specialty flowers, fillers and foliages
- Exposure visits
- Economics and Project preparation.

Course Title: Biotechnological Approaches in Floricultural Crops

Course Code: FLS 604

Credit Hours: (2+1)

This course deals with advances in biotechnology of flower crops. The student needs to be abreast with recent advances in tissue culture, genetic engineering and molecular biology of flower crops.

Theory

Block 1: Scope of biotechnology

Unit I: Scope of biotechnology: Present status of biotechnology, tools techniques and role in floriculture industry, physical factors and chemical factors influencing the growth and development of plant cell, tissue and organs, cyto-differentiation, organogenesis, somatic embryogenesis in important flower crops.

Block 2: Cell, tissue and organ culture

Unit I: Micropropagation: *In-vitro* lines for biotic and abiotic stress – Meristem culture for disease elimination, production of haploids through anther and pollen culture – embryo and ovule culture, micrografting, wide hybridization and embryo rescue techniques, construction of somatic hybrids and cybrids, regeneration and characterization of hybrids and cybrids, *in-vitro* pollination and fertilization, hardening media, techniques and establishment of tissue culture plants in the primary and secondary nursery in important flower crops.

Unit II: Somaclonal variation and *in-vitro* conservation: Somaclonal variation and its applications – variability induction through *in-vitro* mutation, development of cell suspension cultures, types and techniques, Synthetic Seed technology, *in-vitro* production of secondary metabolites, role of bioreactors in production of secondary metabolites, quantification and quality analysis of secondary metabolites using HPLC/ MS/ GCMS/ *in-vitro* conservation and cryo-preservation techniques in important flower crops.

Block 3: Genetic engineering and molecular biology

Unit I: Genetic engineering: Gene cloning, genetic engineering: vectors and methods of transformation – electroporation, particle bombardment, Functional gene analysis techniques like PTGS including VIGS in ornamental plants, Agrobacterium mediated, transgenic plants

in flower crops, Biosafety of transgenics isolation of DNA, RNA, quantification, Polymerase Chain Reaction for amplification; AGE and PAGE techniques; identification of molecular markers in important flower crops.

Unit II: Molecular approaches: Molecular markers as a tool for analysis of genetic relatedness and selection in ornamental crops. Molecular control of flower development, light sensing with respect to plant development, flower pigmentation, fragrance, senescence, ethylene synthesis pathway in important flower crops. Molecular biology- Gene isolation, characterization, manipulation and transfer in important flower crops. Construction of c-DNA library, DNA fingerprinting technique in economic flower crop varieties, RNAi, Genome editing basics, molecular approaches to control ethylene response, Fragrance, Plant Architecture, desirable flower traits, colour, shape, improving postharvest life, improving resistance for environmental stress, approaches to improve flower development, pigment production, secondary metabolite production, post harvest biotechnology of flowers, ornamental plants, achievements of bio-technology in flower crops.

Practical

- Micropropagation, Pollen- Ovule and Embryo culture- Synthetic seed production; *In-vitro* mutation induction, *in-vitro* rooting – hardening at primary and secondary nurseries
- DNA isolation from economic flower crop varieties – Quantification and amplification (2) DNA and Protein profiling – molecular markers, PCR Handling
- Vectors for cloning and particle bombardment
- DNA fingerprinting of flower crop varieties
- Project preparation for establishment of low, medium and high cost tissue culture laboratories .

Course Title: Vertical Gardening

Course Code: FLS 605

Credit Hours: (1+2)

This course deals with development in vertical gardening which is expanding across the country. In view of the unprecedented pollution, advent of smart cities demand for green walls/ living walls is increasing day by day. The students therefore need to be equipped with the advancements taking place to offer solutions.

Theory

Block 1: Importance

Unit I: Scope: Present status of vertical gardening, benefits of vertical gardening, History of vertical gardens, role of indoor plants in mitigating pollution.

Unit II: Growth: Factors influencing the growth and development of the plants including light, humidity, temperature, nutrition, irrigation, growth regulation.

Unit III: Making of vertical gardens: Containers, media, frames, cost effective components, cables, wires, nets for the vertical formations, modular living walls.

Block 2: Green roofing

Unit I: Green Facades: Influence of green facades in providing thermal comfort, atmospheric cleansing and related environmental benefits, Energy saving potential of green façades, Aesthetic appeal of green structures and other relevant studies on urban greening.

Unit II: Mitigation of pollution: Plants suitable, Dust mitigation, Radiation absorption, Pollution mitigation, Acoustic attributes of urban greening.

Unit III: Maintenance: Lifecycle, maintenance, Plants with low light, medium, high intensity requirement, cost effectiveness and overall sustainability of living walls.

Practical

- Identification of plants • Components of vertical gardens • Designing of vertical gardens for different locations • Maintenance of vertical gardens • Economics • Project preparation • Exposure visit.

Course Title: Advances in Breeding of Flower Crops

Course Code: FLS 606

Credit Hours: (2+1)

There have been several advances in application of biotechnology of flower crops. The students need to be aware of a wide array of *in-vitro* and molecular techniques with reference to flower crops.

Theory

Block 1: *In-vitro* techniques and biosynthetic pathways

Unit I: *In-vitro* techniques: Role of biotechnology in improvement of flower crops; *in-vitro* mutagenesis, embryo culture, somaclonal variation, transformation, *in-vitro* cryopreservation, somatic hybridization, anther and ovule culture including somatic embryogenesis.

Unit II: Biosynthetic pathways: Biosynthetic pathways of pigment, fragrance and senescence, flower form; chemistry and importance of secondary metabolites, genomics, proteomics, metabolomics.

Block 2: Molecular techniques

Unit I: Molecular breeding: Molecular breeding and Marker assisted selection; molecular characterization; construction of c-DNA library; High throughput sequencing.

Unit II: Genome editing: Genome editing, CRISPER CAS, gene pyramiding, allele mining.

Unit III: Advances in flower crops: Breeding for biotic and abiotic stresses using biotechnological means; designer flower crops. Advancements in important flower crops like rose, chrysanthemum, carnation, orchids, anthuriums, liliun, gerbera, etc.

Practical

- *In-vitro* mutagenesis, embryo culture, somaclonal variation
- Somatic hybridization, anther and ovule culture and somatic embryogenesis
- Genetic transformation
- Genetic fingerprinting, Genome editing techniques
- PCR, genomics, blotting techniques
- Cloning, marker assisted selection
- Bioinformatics

Course Title: Advances in Production Technology of Flower Crops

Course Code: FLS 607

Credit Hours: (2+1)

Production technology of flower crops is undergoing a rapid change due to advances from other sciences. The students need to keep abreast with these advances in production technology in flower crops.

Theory

Block 1: Production technology

Unit I: Scope and scenario: Commercial flower production; Scope and importance; Global Scenario in cut flower production and trade, varietal wealth and diversity; Soil and

Environment; cut flower, loose flowers, dry flowers and essential oil trade, flower seed production. Special characteristics and requirements. Essential oil industry, recent advances in extraction methods.

Unit II: Cultural operations: Propagation and multiplication; Greenhouse management; Soil/media decontamination techniques; Microirrigation; nutrition and fertigation; slow release fertilizers and biofertilizers; influence of environmental parameters, light, temperature, moisture, humidity and CO₂ on growth and flowering.

Unit III: Crop Regulation: Flower forcing and year-round flowering through physiological interventions; Chemical regulation; Environmental manipulation, important insect pests, diseases, nematodes and their management through IPM and IDM, quarantine measures for export and other export norms.

Unit IV: Advances in production technology of crops: Advances in roses, chrysanthemum, carnation, tuberose, gladiolus, lilum, gerbera, orchids, anthuriums, etc.

Block 2: Mechanization and Post harvest management

Unit I: Mechanization: Mechanization, automation, ICT and AI in floriculture.

Unit II: Post-harvest management: Harvest indices, Harvesting techniques; Post harvest handling for local, distant and export market, Cluster production, Contract farming, FPOs, Value chain management.

Practical

- Greenhouse management; Soil decontamination techniques
- Microirrigation; Nutrition and fertigation
- Special practices- bending, netting, pinching, disbudding, defoliation and chemical pruning, etc.
- Photoperiodic and chemical induction of flowering
- Assessing harvest indices; Post-harvest handling
- Case studies
- Visit to commercial cut flower and essential oil units

Course Title: Advances in Protected Cultivation of Flower Crops

Course Code: FLS 608

Credit Hours: (2+1)

Protected cultivation is more rewarding in production of high value cut flowers. With appropriate structures and plant environment control measures, the constraints of environment prevalent in the region can be overcome allowing almost year-round cultivation. The students need to get updated with the recent advances in protected cultivation.

Theory

Block 1: Production technology

Unit I: Scope and Scenario: Prospects of protected floriculture in India, growing structures, basic considerations in establishment and operation of green houses, functioning and maintenance. Global trade, forward and backward linkages for import clusters, International and national auction houses.

UNIT II: Microclimate management: Environmental control systems in greenhouse, regulation of light through LEDs containers, substrate culture, soil decontamination techniques, aeroponics, hydroponics and vertical farming.

Unit III: Cultural operations: Water and nutrient management, crop regulation, special horticultural practices under protected cultivation of rose, chrysanthemum, carnation, orchids, anthurium, gerbera, liliun, cut

foliage and potted ornamental crops; plant architecture management in ornamental plants.

Unit IV: Advances in flower crops: Advances in protected cultivation of important flowering (rose, chrysanthemum, carnation, gerbera, orchids, anthurium, liliun, and foliage plants (agloenema, monstera, dracaena, syngonium, pothos, diffenbachia, etc.)

Block 2: Precision floriculture and regulations

Unit I: Precision floriculture: Precision floriculture, Principles and concepts, enabling technologies of precision floriculture, remote sensing, sensors, automation in greenhouses, solar greenhouses, retractable greenhouses.

Computers and robotics, decision support systems, apps, cold chain management, use of AI for production and trade.

Unit II: Regulations: PBR/ IPR issues; Forward and backward linkages, 100% EOU, packaging and export standards, Cool chain Management, nontariff barriers, APEDA regulations for export, marketing channels, auction houses, major markets.

Practical

- Growing structures, basic considerations in establishment and operation of greenhouses;
- Environmental control systems in greenhouse;
- Containers, substrate culture, soil decontamination techniques;
- Crop regulation;
- Special horticultural practices under protected cultivation;
- Precision equipments, computers and robotics in precision farming;
- Harvest indices – harvesting, Post harvest handling, marketing;
- Export and cold chain management.

Course Title: Advances in Landscape Gardening

Course Code: FLS 609

Credit Hours: (1+2)

Advances in landscape gardening is a course which deals with principles of landscape design, landscape engineering and site analysis. It will also create awareness on latest developments in landscape gardening among students.

Theory

Unit I

Landscape design: Commercial landscape gardening- History, Plant identification and ecology, Materials of garden design, Design making by different garden styles and types. Design principles in ancient and modern landscape. Principles of designing a commercial landscape project. Role of landscaping in environment improvement, ecology conservation (birds, butterflies, animals). Plant wealth for edges, hedges, herbaceous borders, trees, floral beds, water plants, cacti, ferns, palms, etc.

Unit II

Site analysis: Assessing site and plants adaptability for different locations, Landscape engineering (Topographical survey and designing concept including GIS, GPS, Remote sensing), special techniques in garden landscaping (Burlapping, waterscaping, xeriscaping, hardscaping, lawn establishment, topiary styles specializing, bioaesthetic planning).

Unit III

Software in landscaping: Preparation and drawing of site plan, Learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials (AUTOCAD and ARCHICAD), GIS as a tool for spatial designing.

Unit IV

Landscaping for different situations: Contemporary landscaping, Urban landscaping, Environmental landscaping, Industrial and institutional landscaping, Public and private garden making, play ground landscaping, Inventory management, Landscape restoration, Assessing a successful design in site.

Unit V

Maintenance: Maintenance of different types of gardens, waste water utilisation, historical and archaeological garden sites, Permissions required for bigger projects, carbon sequestration, carbon credits etc.

VII. Practical

- Plant identification
- Materials of garden design, Design making by different garden styles and types
- Assessing site and plants adaptability for different locations
- Way of designing a commercial landscape project
- Landscape engineering (Topographical survey and designing concept)
- Preparation and drawing of site plan
- Learning the basics in computer aided design (CAD) for developing a garden landscape plan
- Handling soft landscape materials (AUTOCAD and ARCHICAD), GIS as a tool for spatial designing
- Case study with the successful landscapist
 - Budget/ Project cost estimating
 - Exposure visits