HORTICULTURE

M.Sc Syllabus

Code	Course tittle	Credits	Semester
Major courses			
Fruit Science			
HOR-PG-C501	Production Technology of Fruit Crops	4	II
HOR-PG-C502	Biodiversity, Conservation and Post-Harvest Management of Fruit Crops	4	III
HOR-PG-C503	Breeding of Fruit Crops	4	II
HOR-PG-C504	Production Technology and Breeding of Fruits Crops - Practical	4	II
HOR-PG-C505	Post-Harvest Management and Biodiversity and Conservation of Fruits - Practical	4	III
Vegetable Science			
HOR-PG-C511	Production of Warm Season Vegetables and Underexploited	4	II
HOR-PG-C512	Production of Cool Season Vegetables and under Exploited Crops	4	III
HOR-PG-C513	Breeding and Seed Production of Vegetable Crops	4	II
HOR-PG-C514	Production, Breeding and Seed Production of Warm Season Vegetable Crops- Practical	4	II
HOR-PG-C515	Production, Breeding and Seed Production of Cool Season Vegetable Crops- Practical	4	III
Floriculture			
HOR-PG-C521	Breeding and Seed production of Ornamental and Flower Crops	4	II
HOR-PG-C522	Production Technology of Cut and Loose Flowers Crops	4	II
HOR-PG-C523	Ornamental Gardening and Landscape Design	4	III
HOR-PG -C524	Production, Breeding and Seed production of Ornamental and Commercial Flower Crops - Practical	4	II
HOR-PG-C525	**Ornamental Gardening and Landscape Design-**	**4**	**III**
Plantation, Spices Medicinal and Aromatic plants			
HOR-PG-C531	Production and Breeding of Plantation Crops	4	II
HOR-PG-C532	Production and Breeding of Spices Crops	4	II
HOR-PG-C533	Production and Breeding of Medicinal and Aromatic Plants	4	III
HOR-PG-C534	Production and Breeding of Plantation and Spice crops-	4	II
HOR-PG-C535	Production and Breeding of Medicinal and Aromatic Plants-Practical	4	III
Minor Courses			
HOR-PG-C541	Principles of Plant Physiology	4	II

HOR-PG-C542	Plant Protection for Horticultural Crops	4	II
HOR-PG-C543	Principles of Plant Physiology - Practical	4	II
HOR-PG-C544	Plant Protection for Horticultural Crops- Practical	4	II
	Any open course offered in other department relevant to the the research topic	4	II
Compulsory Courses			
HOR-PG-C551	Growth and Development Studies and Biotechnological Application	4	I
HOR-PG-C552	Protected Cultivation and Post-Harvest Technology	4	I
HOR-PG-C553	Experimental Design	4	I
HOR-PG-C554	IPR, Research Ethics and Disaster Management	4	I
HOR-PG-C555	Growth & Development, Biotechnology PHT and Protected cultivation- Practical	4	I
HOR-PG-C556	Library Science, Technical writing and Seminar-Practical	4	III

Credit Requirements

Subject	Master's programme
Major	20
Minor	08
Compulsory	24
Research	20
Total Credits	72

Students have to appear comprehensive examination after passing 75 % of the course work. Qualifying marks in comprehensive exam is 55%.

Major subject: The subject in which the students want specialization.
Minor subject: The subject closely related to students major subject.
Compulsory Courses: The courses are relevant supporting major subjects.

FRUIT SCIENCE

HOR PG 501: Production Technology of Fruit Crops

Commercialvarietiesofregional,nationalandinternationalimportance, eco-physiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports with reference to the following crops:

Unit I: Tropical Fruits

Mango, Banana, Citrus, Papaya, Guava, Sapota, Pineapple, Jackfruit and minor fruits of tropics

Unit II: Dryland Fruits
Annonas, Aonla, Pomegranate, Phalsa and Ber

Unit III: Sub Tropical
Litchi, Loquat, Avocado, and Minor Fruits: Mangosteen, Carambola, Bael, Wood Apple, Fig, Jamun, Rambutan, Pomegranate

Unit IV: Temperate and Nuts Crops
Apple, Pear, Quince, Grapes Plums, Peach, Apricot, Cherries, Persimmon, Kiwifruit, Strawberry Walnut, Almond, Pistachio, Pecan Nut and Hazelnut

Reading List:

1. Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. Fruits of India – Tropical and Sub-tropical.3rdEd.Vols.I, II. NayaUdyog.
2. Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. Temperate Fruits- Horticulture.
3. ChadhaKL&PareekOP.1996.(Eds.).Advances in Horticulture.Vol.I. Malhotra Publ. House.
4. Janick J & Moore JN. 1996. Fruit Breeding. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). Fruit Breeding in India. Oxford & IBH.
5. Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.
6. Singh HP, Negi JP & Samuel C.(Eds.).2002.ApproachesforSustainableDevelopment of Horticulture. National Horticultural Board
7. Singh HP, Singh G, Samuel JC & Pathak RK.(Eds.).2003.Precision Farming in Horticulture. NCPAH, DAC/PFDC, CISH, Lucknow.

HORT PG 502: Biodiversity, Conservation and Post Harvest Management of Fruit Crops
Unit I: Biodiversity and conservation
Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity. Present status of gene centers; exploration and collection of germplasm; Conservation of genetic resources – conservation *in situ* and *ex situ.*Germplasmconservation-problemofrecalcitrancy-coldstorageofscions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

Unit II: IPR and GIS
Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group. GIS and documentation of local biodiversity, Geographical indication of the following crops: Mango, Sapota, Citrus, Guava, Banana,Papaya,Grapes,Jackfruit,Custard,Apple,Ber,Aonla,Malus*,Prunus*sp,Litchi,Nuts,Coffee,Tea,Rubber,Cashew, Coconut, Cocoa, Palmyrah, Arecanut, Oil Palmand Betelvine.

Unit III: Maturity Index and Ripening
Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration and transpiration. Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

Unit IV: Storage and Packaging of Fruits

Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage-ventilated, refrigerated, MAS, CA storage, physical injuries and disorders. Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies. Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Reading List:

1. FrankelOH&HawkesJG.1975.*CropGeneticResourcesforTodayandTomorrow*.CambridgeUniversity Press.
2. PeterKV&AbrahamZ.2007.*BiodiversityinHorticulturalCrops*.Vol.I.DayaPubl. House.
3. PeterKV.2008.*BiodiversityofHorticulturalCrops*.Vol.II.DayaPubl. House.
4. Haid NF &Salunkhe SK. 1997. Post Harvest Physiology and Handling of Fruits and Vegetables.Grenada Publ.
5. Mitra SK. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits.CABI.
6. Ranganna S. 1997. Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill.
7. Sudheer KP & Indira V. 2007. Post Harvest Technology of for Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals. CABI.

HOR PG 503: Breeding of Fruit Crops

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

Unit I: Tropical Fruits

Mango, Banana, Papaya, Citrus, Grapes, Guava and Sapota

Unit II: Sub Tropical Fruits

Pineapple, Mangosteen, litchi, Jackfruit, and avocado

Unit III: Dryland Fruits

Custard Apple, Aonla, Jamun, Phalsa, and Ber

Unit IV: Temperate Fruits

Apple, Pear, Plums, Peach, Apricot, Cherries, Raspberry, Mulberryand Strawberry and Some Nuts

Reading List:

1. BoseTK,MitraSK&SanyolD.(Eds.).2002.FruitsofIndia–Tropical and Sub-tropical. 3rdEd. Vols. I, II. NayaUdyog.
2. ChadhaKL&PareekOP.1996.(Eds.).AdvancesinHorticulture.Vol.I. MalhotraPubl. House.
3. ChadhaKL&ShikhamanySD. 1999. The Grape: Improvement, ProductionandPost-HarvestManagement. Malhotra Publ. House.

4. JanickJ & Moore JN. 1996. Fruit Breeding. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). Fruit Breeding in India.Oxford & IBH.
5. RadhaT & Mathew L. 2007. FruitCrops. New India Publ. Agency.
6. SinghS,ShivankarVJ,SrivastavaAK&SinghIP.(Eds.).2004.Advances in Citriculture. Jagmander Book Agency.
7. PeterKV.2008.*BiodiversityofHorticulturalCrops*.Vol.II.DayaPubl. House.

HOR PG 504: Production Technology and Breeding of Fruits Crops - Practical

Unit I: Principles

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

Unit II: Breeding of fruit crops

Developing breeding programme for specific traits, visit to research stations working on tropical, subtropical and temperate fruit improvement.

Unit III: Essential breeding techniques

Characterization of germplasm, blossom biology, study of anthesis, estimating fertility status, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for resistance.

Unit IV: Documentation

Documentation of germplasm–maintenance of passport data and other records of accessions. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

Reading List:

1. Bose TK, Mitra SK & Sanyol D.(Eds.).2002.FruitsofIndia–Tropical and Sub-tropical. 3rdEd. Vols. I, II. Naya Udyog.
2. Chadha KL&PareekOP.1996.(Eds.).Advances in Horticulture. Vol.I. Malhotra Publ. House.
3. Chadha KL & Shikhamany SD. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.
4. Janick J & Moore JN. 1996. Fruit Breeding. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). Fruit Breeding in India. Oxford & IBH.
5. Radha T & Mathew L. 2007. FruitCrops. New India Publ. Agency.
6. Singh S, Shivankar VJ, SrivastavaAK & SinghIP.(Eds.).2004.Advances in Citriculture. Jagmander Book Agency.
7. PeterKV.2008.*BiodiversityofHorticulturalCrops*.Vol.II.DayaPubl. House.

HOR PG 505: Post Harvest Management and Biodiversity and Conservation of Fruits – Practical

Unit I: Physiology of fruit crops I
Analyzing maturity stages of commercially important horticultural crops,improved packing and storage of important horticultural commodities,physiological loss in weight of fruits.

Unit II: Physiology of fruit crops II
Estimation oftranspiration, respiration rate, ethylene release and study of vase lifeextension in cut flower using chemicals, estimation of qualitycharacteristics in stored fruits, cold chain management

Unit III: Post harvest management
Visit to cold storage and CA storage units, visit to fruit and vegetableprocessing units,project preparation, evaluation of processed horticulturalproducts.

Unit IV: Documentation and conservation of germplasm
Documentationofgermplasm–maintenanceofpassportdataandother records of accessions; field exploration trips, exercise on *ex situ* conservation–coldstorage,pollen/seedstorage,cryopreservation. Visitto National GeneBank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

Reading List:

1. FrankelOH&HawkesJG.1975.*CropGeneticResourcesforTodayandTomorrow*.CambridgeUniversity Press.
2. PeterKV&AbrahamZ.2007.*BiodiversityinHorticulturalCrops*.Vol.I.DayaPubl. House.
3. PeterKV.2008.*BiodiversityofHorticulturalCrops*.Vol.II.DayaPubl. House.
4. Haid NF &Salunkhe SK. 1997. Post Harvest Physiology and Handling of Fruits and Vegetables.Grenada Publ.
5. Mitra SK. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits.CABI.
6. Ranganna S. 1997. Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill.
7. Sudheer KP & Indira V. 2007. Post Harvest Technology of for Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals. CABI.

VEGETABLE SCIENCE

HOR PG 511:Production Technology of Warm Season Vegetables and Underexploited Crops
Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and economics of crop production.

Unit I: Solanaceous vegetables and Okra
Tomato, Eggplant, Chilli, Sweet Peppers and Okra

Unit II: Cucurbitaceous Vegetables
Cucumber, Gourds, Melons, Pumpkin & Squashes, and Chayote

Unit III: Beans, Tuber and Leafy Vegetables
French Bean, Cluster Bean, Indian Bean, Cowpea, Tapioca, Sweet Potato, Colocasia, Amaranthus, Basella, Moringaand Curry Leaf.

Unit IV: Summer Season Underexploited Vegetables
Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jackbean and sword bean, sweet gourd, spine gourd, pointed gourd, oriental pickling melon and little gourd (kundru).

Reading List:

1. BoseTK,KabirJ, MaityTK, ParthasarathyVA &SomMG. 2003. *Vegetable Crops*. Vols. I-III. NayaUdyog.
2. FageriaMS, ChoudharyBR &Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
3. GopalakrishananTR. 2007. *Vegetable Crops*. New India Publ. Agency.
4. RanaMK. 2008. *Olericulture in India*. Kalyani Publ.
5. SalunkheDK&KadamSS.(Ed.).1998.*HandBookofVegetableScience and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
6. SinghDK.2007.*ModernVegetableVarietiesandProductionTechnology*. International Book Distributing Co.
7. ThamburajS&Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*.ICAR.

HOR PG 512: Production Technology of Cool Season Vegetables and Underexploited Crops
Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and economics of crop production.

Unit I: Potato and Cole Crops
Potato, Cole Crops: Cabbage, Cauliflower, Knol Kohl, Sprouting Broccoli, Brussel's Sprout

Unit II: Root and Bulb Vegetable Crops
Carrot, Radish, Turnip, Beet Root, Onion, Garlic and Leek

Unit III: Peas, Beans and Green Leafy Vegetable Crops
Garden Pea, Broad Bean, Spinach and Spinach Beet

Unit IV: Production Technology of Underexploited Winter Vegetable Crops
Asparagus, Artichoke, Chinese Cabbage, Kale, Celery, Parsley, Parsnip, Lettuce, Rhubarb, Bathua (Chenopods) and Chekurmanis.

Reading List:

1. BoseTK,KabirJ, MaityTK, ParthasarathyVA &SomMG. 2003. *Vegetable Crops*. Vols. I-III. NayaUdyog.
2. FageriaMS, ChoudharyBR &Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.

3. GopalakrishananTR. 2007. *Vegetable Crops*. New India Publ. Agency.
4. RanaMK. 2008. *Olericulture in India*. Kalyani Publ.
5. SalunkheDK&KadamSS.(Ed.).1998.*HandBookofVegetableScience and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
6. SinghDK.2007.*ModernVegetableVarietiesandProductionTechnology*. International Book Distributing Co.
7. ThamburajS&Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*.ICAR.

HOR PG 513: Breeding and Seed Production of Vegetable Crops

Unit I: Principles of Vegetable Breeding

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

Unit II: Breeding of Self, Cross and Clonally Propagated Crops

Potato, tomato, eggplant, hot pepper, sweet pepper, okra, Peas and beans, cucumber, gourds, melons, pumpkins and squashes, cabbage, cauliflower, carrot, beetroot, radish, onion, garlic, sweet potato and tapioca.

Unit III: Principles of Seed Production of Vegetable Crops

Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India, genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production. Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control

Unit IV: Seed Production Techniques in Vegetable Crops

Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology. Agro-techniques for seed production in Solanaceous Vegetables, Cucurbits, Leguminous Vegetables, Cole Crops, Bulb Crops, Leafy Vegetables, Okra, Vegetatively Propagated Vegetables.

Reading List:

1. DhillonBS,TyagiRK,SaxenaS.&RandhawaGJ.2005.*PlantGeneticResources:Horticultural Crops*. Narosa Publ. House.
2. FageriaMS,Arya PS&ChoudharyAK.2000.*VegetableCrops:Breeding and Seed Production*. Vol. I. Kalyani.
3. HayesHK, Immer FR&SmithDC.1955.*MethodsofPlantBreeding*. McGraw-Hill.
4. KallooG.1998.*VegetableBreeding*.Vols.I-III(CombinedEd.).Panima Edu.Book Agency.
5. PeterKV&PradeepkumarT.2008.*GeneticsandBreedingofVegetables*.Revised,ICAR.
6. RaiN&RaiM.2006.*HeterosisBreedinginVegetableCrops*.NewIndiaPubl.Agency.

7. Singh PK, DasguptaSK &TripathiSK. 2004. *Hybrid Vegetable Development*.International Book Distributing Co.

HOR PG 514:Production Technology, Breeding and Seed Production of Warm Season Vegetable Crops- Practical

Unit I: Cultural Operations in Warm Season Vegetable Crops

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

Unit II: Cultural Operations in Summer Underexploited Vegetable Crops

Identification of seeds; botanical description of plants; layout and planting; Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control), short-term experiments of summer season underexploited vegetables

Unit III: Essential Breeding Techniques in Warm Season Vegetable Crops

Selection of desirable plants from breeding population observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; induction of flowering, palanological studies, selfing and crossing techniques in warm season vegetable crops; Screening techniques for insect-pests, disease and environmental stress resistance warm season crops, demonstration of sib-mating and mixed population; molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques. Visit to breeding block.

Unit IV: Seed Production and Processing Techniques in Warm Season Vegetable Crops

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

Reading List:

1. FageriaMS, ChoudharyBR &Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
2. GopalakrishananTR. 2007. *Vegetable Crops*. New India Publ. Agency.
3. RanaMK. 2008. *Olericulture in India*. Kalyani Publ.
4. FageriaMS,AryaPS&ChoudharyAK.2000.*VegetableCrops:Breeding and Seed Production*. Vol. I. Kalyani.
5. HayesHK,ImmerFR&SmithDC.1955.*MethodsofPlantBreeding*. McGraw-Hill.
6. KallooG.1998.*VegetableBreeding*.Vols.I-III(CombinedEd.).Panima Edu.Book Agency.
7. Singh PK, DasguptaSK &TripathiSK. 2004. *Hybrid Vegetable*

Development.International Book Distributing Co.

HOR PG 515:Production Technology, Breeding and Seed Production of Cool Season Vegetable Crops- Practical

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

Unit II: Cultural Operations in Winter Underexploited Vegetable Crops
Identification of seeds; botanical description of plants; layout and planting; cultural operations (fertilizer application, sowing, mulching, irrigation, weed control), short-term experiments of winter season underexploited vegetables.

Unit III: Essential Breeding Techniques in Cool Season Vegetable Crops
Selection of desirable plants from breeding population observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; induction of flowering, palanological studies, selfing and crossing techniques in cool season vegetable crops; Screening techniques for insect-pests, disease and environmental stress resistance warm season crops, demonstration of sib-mating and mixed population; molecular marker techniques to identify useful traits in the cool season vegetable crops and special breeding techniques.

Unit IV: Seed Production and Processing Techniques in Cool Season Vegetable Crops
Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; rouging of off-type; methods of hybrid seed production in important cool season vegetable crops. Seed extraction techniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

Reading List:

1. FageriaMS, ChoudharyBR &Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
2. GopalakrishananTR. 2007. *Vegetable Crops*. New India Publ. Agency.
3. RanaMK. 2008. *Olericulture in India*. Kalyani Publ.
4. FageriaMS,AryaPS&ChoudharyAK.2000.*VegetableCrops:Breeding and Seed Production*. Vol. I. Kalyani.
5. HayesHK,ImmerFR&SmithDC.1955.*MethodsofPlantBreeding*. McGraw-Hill.
6. KallooG.1998.*VegetableBreeding*.Vols.I-III(CombinedEd.).Panima Edu.Book Agency.
7. Singh PK, DasguptaSK &TripathiSK. 2004. *Hybrid Vegetable Development*.International Book Distributing Co.

FLORICULTURE & LANDSCAPING

HOR PG 521: Breeding and Seed Production for Ornamental and Flower Crops

Unit I: Introduction

Principles, evolutionofvarieties,origin,distribution,genetic resources, genetic divergence, patents and plant variety protectioninIndia.Genetic inheritance offlowercolour,doubleness,flowersize,fragrance, post harvest life.Breedingmethodssuitableforsexuallyandasexuallypropagatedflower crops and ornamental plants-- introduction, selection, domestication, polyploidy and mutation breeding for varietal development, role of heterosis, productionofhybrids, male sterility,incompatibilityproblems, seed production of flower crops.

Unit II: Breeding of Flower Crops

Breeding constraintsandachievementsmadeincommercialflowers-Rose,Jasmine,Chrysanthemum,Marigold,Tuberose,Crossandra,Carnation,Dahlia, Gerbera, Gladioli, Orchids, Anthurium, Aster, Heliconia, Liliums, Nerium. Breeding Constraints and achievements made in ornamental plants – Petunia, Hibiscus, Bougainvillea, Flowering Annuals (Zinnia, Cosmos, Dianthus,Snapdragon, Pansy)andornamentalfoliages. Introductionand selection of plants for waterscaping and xeriscaping.

Unit III: Seed Production of Flower Crops I

Definitionofseedanditsquality,newseedpolicies;DUStest,scopeof flower and ornamental seed industry in India.Geneticalandagronomicalprinciplesofseedproduction;methodsofseed production; use of growth regulators and chemicals in seed production; floral biology, pollination, breeding behaviour,seed development and maturation; methods of hybrid seed production.

Unit IV: Seed Production of Flower Crops II

Categoriesofseed;maintenanceofnucleus,foundationandcertifiedseed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.Physiological maturity, seed harvesting, extraction, curing, drying, grading, seedprocessing,seedcoatingandpelleting,packaging(containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

Reading List:

1. BhattacharjeeSK.2006.*AdvancesinOrnamentalHorticulture*.Vols.I-VI. PointerPubl.
2. BoseTK &Yadav LP. 1989.*Commercial Flowers*.NayaProkash.
3. ChadhaKL &ChoudhuryB.1992. *Ornamental Horticulturein India*. ICAR.
4. ChadhaKL.1995.*AdvancesinH orticulture*.Vol.XII.MalhotraPubl. House.
5. ChaudharyRC. 1993. *Introduction to Plant Breeding*. Oxford & IBH.
6. Singh BD. 1990. *Plant Breeding*. Kalyani.
7. Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.

HOR PG 522–Production Technology of Cut and Loose Flower Crops

Unit I:Introduction

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and

diversity, area under cut flowers and productionproblemsin India-Patentrights,nurserymanagement,media for nursery, special nursery practices.Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.Special horticulturalpractices,useofgrowthregulators,physiologicaldisorders and remedies,Cutflowerstandards andgrades,harvesting indices,harvestingtechniques, post-harvest handling,Methodsofdelayingfloweropening,Pre-cooling, pulsing, packing, Storage and transportation, marketing, export potential, institutional support, Agri Export Zones.

Unit II: Production of Cut Flowers I

Growing environment, open cultivation, protected cultivation, soil requirements,artificialgrowingmedia,soildecontaminationtechniques, influence of environmental parameters, light, temperature,moisture, humidity and CO_2 ongrowth and flowering, water and nutrient management, fertigation, weed management, rationing, training andpruning, disbudding, IPM and IDM, post harvest handling, purposes of following crops:

Crops: Cutrose,Cutchrysanthemum,Carnation,Gerbera,Gladioli,Tuberose, Orchids,Anthurium,Aster,Liliums.

Unit III: Production of Cut Flowers II

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growingmedia,soildecontaminationtechniques, plantingmethods, influence of environmental parameters, light, temperature,moisture, humidity and CO_2 ongrowth and flowering, water and nutrient management, fertigation, weed management, rationing, training andpruning, disbudding, IPM and IDM, post harvest handling, of following crops:

Crops: Birdofparadise,alstroemeria, ornamentalginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

Unit IV: Production of Loose Flowers

Soil andclimate requirements, field preparation, systems of planting, precision farming techniques.Waterandnutrientmanagement,weedmanagement,rationing,training andpruning,pinchinganddisbudding,specialhorticulturalpractices,useof growth regulators, physiological disorders and remedies, IPM and IDM. Flowerforcingandyearroundflowering,productionforspecialoccasions through physiological interventions,chemical regulation.Harvestindices,harvestingtechniques,post-harvesthandlingandgrading, pre-cooling,packingandstorage,valueaddition,concreteandessentialoil extraction details for the following crops: Jasmine, Scented Rose, Chrysanthemum, Marigold, Tuberose, Crossandra, Nerium, Hibiscus, Barleria, Celosia,Gomphrena,Non-Traditional Flowers: Nyctanthes,Tabernaemontana, Ixora, Lotus, Lilies, Tecoma, Champaka, Pandanus.

Reading list:

1. BhattacharjeeSK.2006.*AdvancesinOrnamentalHorticulture*.Vols.I-VI. PointerPubl.
2. BoseTK &Yadav LP. 1989.*Commercial Flowers.*NayaProkash.
3. ChadhaKL &ChaudhuryB. 1992. *Ornamental Horticulturein India*. ICAR.
4. LauriaA&RiesVH.2001.*Floriculture–FundamentalsandPractices.*Agrobios.
5. PrasadS & Kumar U. 2003. *Commercial Floriculture.*Agrobios.

6. Nelson PV. 1978. *Green House Operation and Management*. Reston Publ.Co.
7. ReddyS,JanakiramB,BalajiT,KulkarniS&MisraRL.2007.*Hightech loriculture*. Indian Societyof Ornamental Horticulture, New Delhi.

HOR PG 523: Ornamental Gardening and Landscape Design

Unit I: Introduction to Ornamental Gardening and Landscape Design

Landscapedesigns,typesofgardens,English,Mughal,Japanese,Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens.Gardenplantcomponents,arboretum,shrubbery,fernery,palmatum,arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents,herbs,annuals,flowerbordersandbeds,ground covers,carpet beds, bamboo groves; Non-plantcomponents.

Unit II: Types of Garden and Landscaping of specific places

Specialtypesofgardens,vertical garden,roofgarden,boggarden,sunkengarden,rockgarden,clockgarden, colour wheels, temple garden, sacred groves.Urban landscaping,Landscaping for specific situations, institutions, industries,residents,hospitals,roadsides,trafficislands,damsites,ITparks, corporates.Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening,waterscaping,xeriscaping, hardscaping.

Unit III: Turf and turf management I

Prospects of turf industry; site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment. Turfgrasses-Types,species,varieties,hybrids;Selectionofgrassesfor different locations; Grouping according to climaticrequirement- Adaptation; Turfing for roof gardens.

Unit IV: Turf and turf management II

Preparatory operations; Growing media used for turf grasses - Turf establishmentmethods, seeding, sprigging / dibbling, plugging, sodding/ turfing, turf plastering, hydro-seeding,astro-turfing.Turfmanagement–Irrigation,nutrition,specialpractices,aerating,rolling, soiltopdressing,useofturfgrowthregulators(TGRs)andmicronutrients, Turfmowing—mowingequipments,techniquestominimizewearand compaction, weed control, biotic and abiotic stress management in turfs. Establishmentandmaintenanceofturfsforplaygrounds,viz.golf,football, hockey, cricket, tennis, rugby, etc.

Reading List:

1. Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.
2. Nambisan KMP.1992. *Design Elements of Landscape Gardening*. Oxford & IBH.
3. Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
4. Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.
5. Christians N E 2007. *Fundamentals of Turfgrass Managemen.* John Wiley & Sons, Inc
6. Turgeon A J 1980. *Turfgrass Management.* Reston Publishing Company, Inc
7. Christine Wein-Ping Yu 1987. *Computer-aided Design: Application to Conceptual Thinking in Landscape Architecture.* Agrobios.

HOR PG 524: Production, Breeding and Seed production of Ornamental and Commercial Flower Crops - Practical

Unit I:Breeding of flower crops

Descriptionofbotanical features- Catalogusingofcultivars,varietiesand speciesinflowers,floralbiology,selfingandcrossing,evaluationofhybrid progenies, Induction of mutants through physical and chemicalmutagens,inductionofpolyploidy,screeningofplantsforbiotic, abioticstressesandenvironmental pollution, *invitro*breedinginflower crops and ornamental plants.

Unit II: Seed production of flower crops

Seed extraction techniques; handling of seed processing and seed testingequipments; seed sampling; testing of seeds for seed purity, germination,vigourandhealth;visittoseedprocessingunits,seedtesting laboratory and seed production farms.

Unit III: Production of flower crops

Botanicaldescriptionofvarieties,propagationtechniques,mistchamber operation,trainingandpruningtechniques,practicesinmanuring,dripand fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques,

Unit III: Management in flower Crops

Post-harvest handling, cold chain, project preparation for regionally important cut flowers/ loose flowers, visit to commercial floriculture units and case study.essential oil extraction units and markets.

Reading List:

1. BhattacharjeeSK.2006.*AdvancesinOrnamentalHorticulture*.Vols.I-VI. PointerPubl.
2. BoseTK &Yadav LP. 1989.*Commercial Flowers.*NayaProkash.
3. ChadhaKL &ChoudhuryB.1992. *Ornamental Horticulturein India*. ICAR.
4. ChadhaKL.1995.*AdvancesinH orticulture.*Vol.XII.MalhotraPubl. House.
5. ChaudharyRC. 1993. *Introduction to Plant Breeding.* Oxford & IBH.
6. Singh BD. 1990. *Plant Breeding*. Kalyani.
7. Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.

HOR PG 525: Ornamental Gardening and Landscape Design- Practical

Unit I:Ornamental Gardening I

Selectionofornamentalplants,practicesinpreparingdesignsforhome gardens, industrial gardens, institutional gardens, corporates, avenue planting,

Unit II:Ornamental Gardening II

Practices in planningandplantingofspecialtypesofgardens, burlapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and

botanical gardens, case study on commercial landscape gardens.

Unit III:Turf and Turf Management I
Identification of turf grasses, Preparatory operations in turf making, Practices in turf establishment, Layout of macro and micro irrigation systems, Water and nutrient management; Special practices – mowing, raking,rolling,soiltopdressing, weedmanagement;Bioticandabiotic stressmanagement;

Unit IV: Turf and Turf Management II
Projectpreparationforturf establishment,visitto IT parks,model cricket and golf grounds, airports, co-operates, Govt. organizations; Renovation of lawns; Turf economics.

Reading List:

1. Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.
2. Nambisan KMP.1992. *Design Elements of Landscape Gardening*. Oxford & IBH.
3. Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
4. Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.
5. Christians N E 2007. *Fundamentals of Turfgrass Managemen.* John Wiley & Sons, Inc
6. Turgeon A J 1980. *Turfgrass Management.* Reston Publishing Company, Inc
7. Christine Wein-Ping Yu 1987. *Computer-aided Design: Application to Conceptual Thinking in Landscape Architecture.* Agrobios.

PLANTATION, SPICES, MEDICINAL & AROMATIC PLANTS

HOR PG 531: Production and Breeding Technology of Plantation Crops

Unit I: Principles of production
Roleofplantationcropsinnationaleconomy, area of production, exportpotential,IPRissues, clean developmentmechanism, classification and varietal wealth. Costbenefit analysis under organicfarming,precision farming for plantation crops,systems of cultivation, multitiercropping, photosyntheticefficienciesofcropsatdifferenttiers, processing methods.

Unit II: Production technology I
Production including temperature, light, humidity and soil pH,highdensityplanting,nutritionalrequirements,physiological disorders,roleofgrowthregulatorsandmacroandmicronutrients,water requirements, fertigation, moistureconservation, shade regulation, weed management, training and pruning, crop regulation,maturity indices, harvesting for following Crops:Coffee and Tea, Cashew and Cocoa, Rubber

Unit III: Production technology II
Production including temperature, light, humidity and soil pH,highdensityplanting,nutritionalrequirements,physiological disorders,roleofgrowthregulatorsandmacroandmicronutrients,water requirements, fertigation, moistureconservation, shade regulation, weed management, training and pruning, crop

regulation,maturity indices, harvesting for following Crops:Palmyrahand Oil Palm, Coconut andArecanut, Wattle and Betel Vine

Unit IV: Breeding techniques

Important speciesandcultivars,blossom biology, breeding objectives, approaches for crop improvement, breeding techniques and constraints for the following crops: Coffee and Tea, Cashew and Cocoa, Rubber, Palmyrah and Oil Palm, Coconut andArecanut, Wattle and Betel Vine

Reading List:

1. Chopra VL & Peter KV. 2005. Handbook of Industrial Crops. Panima.
2. Harler CR. 1963. The Culture and Marketing of Tea. Oxford Univ. Press.
3. Kurian A & Peter KV. 2007. Commercial Crops Technology. New India Publ. Agency.
4. Peter KV. 2002. Plantation Crops. National Book Trust.
5. Pradeep Kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. Management of Horticultural Crops. Part I, II. New India Publ. Agency.
6. Rai PS & Vidyachandram B. 1981. Review of Work Done on Cashew. UAS, Research Series No.6, Bangalore.
7. Srivastava HC, Vatsaya B & Menon KKG. 1986. Plantation Crops – Opportunities and Constraints. Oxford & IBH.

HOR PG 532: Production and Breeding of Spices Crops

Unit I: Introduction

Introduction,importanceofspicecrops-historicalaccent,presentstatus-nationalandinternational,futureprospects.

Unit II: Production technology I

Botanyandtaxonomy,climatic andsoilrequirements,commercialvarieties/hybrids,siteselection,layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, interculturaloperations,weedcontrol,mulching, physiologicaldisorders, harvesting,postharvestmanagement,plantprotectionmeasures andseed planting material and micro-propagation, precision farming, organic resourcemanagement,organiccertification,qualitycontrol,pharmaceutical significance and protected cultivationof following crops:Blackpepper, CardamomClove, Cinnamon and Nutmeg, Allspice, Turmeric, Ginger snd Garlic

Unit III:Production technology II

Botany and taxonomy, climatic andsoilrequirements,commercialvarieties/hybrids,siteselection,layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, interculturaloperations,weedcontrol,mulching, physiologicaldisorders, harvesting,postharvestmanagement,plantprotectionmeasures andseed planting material and micro-propagation, precision farming, organic resourcemanagement,organiccertification,qualitycontrol,pharmaceutical significance and protected cultivationof following crops:Coriander,Fenugreek, Cumin,Fennel, Ajowain, Dill, Celery, Tamarind, Garcinia and Vanilla

Unit IV: Breeding techniques

Important speciesandcultivars,blossom biology, breeding objectives, approaches for crop improvement, breeding techniques and constraints for the following crops: Blackpepper, CardamomClove, Cinnamon and Nutmeg,

Allspice, Turmeric, Ginger And Garlic, Coriander,Fenugreek, Cumin,Fennel, Ajowain, Dill, Celery, Tamarind, Garcinia and Vanilla

Reading List:

1. Agarwal S, Sastry EVD & Sharma RK. 2001. Seed Spices: Production, Quality, Export. Pointer Publ.
2. Arya PS. 2003. Spice Crops of India. Kalyani.
3. Bhattacharjee SK. 2000. Hand Book of Aromatic Plants. Pointer Publ.
4. Kumar NA, Khader P, Rangaswami & Irulappan I. 2000. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford & IBH.
5. Nybe EV, Miniraj N & Peter KV. 2007. Spices. New India Publ. Agency.
6. Parthasarthy VA, Kandiannan V & Srinivasan V. 2008. Organic Spices. New India Publ. Agency.
7. Peter KV. 2001. Hand Book of Herbs and Spices. Vols. I-III. Woodhead Publ. Co. UK and CRC USA

HOR PG 533: Production and Breeding of Medicinal and Aromatic Plants

Unit I: Production technology of medicinal plants

Herbalindustry,WTOscenario,Exportandimportstatus,Indiansystemof medicine,IndigenousTraditionalKnowledge,IPRissues,Classificationof medicinal crops, Systems of cultivation, Organic production, Role of institutions and NGO's in production, GAP in medicinal crop production. ProductiontechnologyforSenna,Periwinkle,Coleus,Aswagandha,Glory lily,Sarpagandha,*Dioscorea*sp.,*Aloevera*,*Phyllanthusamarus, Andrographispaniculata.*Production technologyfor Medicinal solanum, Isabgol, Poppy, Safedmusli, *Stevia rebaudiana, Mucunapruriens, Ocimum sp.*Postharvesthandling–Drying,Processing,Grading,PackingandStorage, processing and value addition; GMPand Quality standards in herbal products.Influenceof biotic and abiotic factors on the production of secondary metabolites, Regulations for herbal raw materials,Phytochemical extraction techniques.

Unit II: Production technology of aromatic plants

Aromatic industry,WTO scenario, Export and import status, Indian perfumeryindustry, History, Advancements in perfume industry.Production technology for palmarosa, lemongrass, citronella,vettiver, geranium, artemisia,mentha, ocimum, eucalyptus, rosemary, thyme, patchouli, lavender, marjoram, oreganum.Post-harvesthandling, Distillation methods, advanced methods, Solvent extractionprocess,steamdistillation,Perfumesfromnon-traditionalplants, Qualityanalysis,Valueaddition,Aromachemicals,qualitystandardsand regulations.Institutionalsupport and international promotion of essential oil and perfumery products.

Unit III: Fundaments of breeding in MAP

Plant bio-diversity, conservation of germplasm, IPR issues, Major objectives of breeding of Medicinal and Aromatic Crops, Scope for introduction;cytogeneticbackgroundofimportantMedicinalandAromatic Crops;ScopeforimprovementofMedicinalandAromaticCropsthrough selection, intra and interspecific hybridization, induced autotetraploidy, mutation breeding and biotechnological approaches. Breedingforyieldandqualityimprovementinmedicinalplants,Breeding forhighherbageyield,ess entialoilandqualitycomponents,secondary

metabolitesinmedicinalandaromaticcrops;Geneticsofactiveprinciples andassaytechniquesusefulinevaluationofbreeder'smaterial.

Unit IV: Breeding methods and achievements in MAP

Achievementsandprospectsinbreedingofmedicinalcrops,viz.*Cassia angustifolia, Catharanthusroseus, Gloriosasuperba, Coleus forskohlii, Stevia,Withaniasomnifera,Papaver somniferum,Plantagoovata, Dioscoreasp.Chlorophytumsp,Rauvolfiaserpentina,Aloe vera, Ocimumsp, Phyllanthusamarus, Solanumsp.*Geranium,vettiver,Lemongrass, Palmarosa,citronella,Rosemary,Patchouli,Eucalyptus,Artemisia and Mint.

Reading List:

1. Atal CK & Kapur BM. 1982. Cultivation and Utilization of Aromatic Plants. RRL, CSIR, Jammu.
2. Atal CK & Kapur BM. 1982. Cultivation and Utilization of Medicinal Plants. RRL, CSIR, Jammu.
3. Farooqi AA, Khan MM & Vasundhara M. 2001. Production Technology of Medicinal and Aromatic Crops. Natural Remedies Pvt. Ltd.
4. Hota D. 2007. Bio Active Medicinal Plants. Gene Tech Books.
5. Khan IA & Khanum A. Role of Bio Technology in Medicinal and Aromatic Plants. Vol. IX. Vkaaz Publ.
6. Panda H. 2002. Medicinal Plants Cultivation and their Uses. Asia Pacific Business Press.
7. Ramawat KG & Merillon JM. 2003. BioTechnology-Secondary Metabolites. Oxford & IBH.

HOR PG 534: Production and Breeding of Plantation and Spice Crops- Practical

Unit I: Production technology of plantation crops

Descriptionofbotanicalandvarietalfeatures,selectionofmotherpalms andseedlingsincoconutandarecanut,soiltestcropresponsestudiesand manuringpractices,pruningandtraining,maturitystandards,harvesting, Project preparation for establishingplantations, Visit to plantations.

Unit II: Production technology of spice crops

Identification of seeds and plants, botanical description of plant;preparationofherbarium,propagation,nurseryraising,fieldlayoutand methodofplanting,culturalpractices,harvesting, drying, storage, packagingandprocessing,valueaddition;shorttermexperimentsonspice crops.

Unit III: Breeding of plantation crops

Important Plantation Crops- Description and cataloguing of germplasm, pollen viability tests, pollengermination, survey and clonal selection, screening techniques for abioticstresses, screening and rating for pest, disease and stress resistance ininbreds and hybrids, estimation of quality and processing characters forquality improvement, use of mutagenes and colchicine for inducingmutation and ploidy hanges, practices in different methods of breedingand*in vitro* breeding techniques.

Unit IV: Breeding of spice crops

Important Spices Crops- Description and cataloguing of germplasm, pollen viability tests, pollengermination, survey and clonal selection, screening techniques for abioticstresses, screening and rating for pest, disease and stress resistance ininbreds and hybrids, estimation of quality and processing characters forquality improvement, use of mutagenes and colchicine for inducingmutation and ploidy hanges, practices in different methods of breedingand*in vitro* breeding techniques.

Reading List:

1. Chadha KL & Rethinam P. (Eds.).1993. Advances in Horticulture. Vol. IX. Plantation Crops and Spices. Part-I. Malhotra Publ. House.
2. Chadha KL, Ravindran PN & Sahijram L. 2000. Biotechnology in Horticultural and Plantation Crops. Malhotra Publ. House.
3. Chadha KL. 1998. Advances in Horticulture. Vol. IX. Plantation and Spices Crops. Malhotra Publishing House, New Delhi.
4. Chopra VL & Peter KV. Handbook of Industrial Crops. Haworth Press. Panama International Publishers, New Delhi (Indian Ed.).
5. Damodaran VK, Vilaschandran T &.Valsalakumari PK. 1979. Research on Cashew in India. KAU, Trichur.
6. Ferwerden FP & Wit F. (Ed.). 1969. Outlines of Perennial Crop Breeding in the Tropics. H. Veenman & Zonen.
7. Harver AE. 1962. Modern Coffee Production. Leonard Hoff.

HOR PG 535: Production and Breeding of Medicinal and Aromatic plants- Practical

Unit I: Production technology of MAP I

Botanicaldescription,Propagationtechniques,Maturitystandards,Digital documentation, Extraction of secondary metabolites,Projectpreparationfor commercially importantmedicinalcrops,Visittomedicinalcropfields, Visit to herbal extractionunits.

Unit II:Production technology of MAP II

Harvesting and ExtractionofEssentialoils for important crops,Projectpreparationforcommerciallyimportant Aromatic crops,Visittodistillationandvalueadditionunits–Visitto CIMAP.

Unit III:Breeding of MAP I

Characterization and evaluation of germplasmaccessions, Blossom biology, studies on pollen behaviour, practices in hybridization,evaluationofbiometricaltraitsandquality traits,screeningforbioticand abioticstresses,haploidculture,protoplast cultureandfusion-inductionofsomaclonal variation and screening he variants. Identification and familiarization of spices; floral biology anthesis; fruitset;selfingandcrossingtechniques;descriptionofvarieties.

Unit IV:Breeding of MAP II

Salient featuresofimprovedvarietiesandcultivarsfrompublicandprivatesector, bioinformatics, visitto radiotracer laboratory, genetictransformation in plantation crops for resistance to biotic stress/quality improvement etc.

Reading List:

1. Atal CK & Kapur BM. 1982. Cultivation and Utilization of Medicinal Plants. RRL, CSIR, Jammu.
2. Chadha KL & Gupta R. 1995. Advances in Horticulture. Vol. XI. Malhotra Publ. House.
3. Farooqi AA, Khan MM & Vasundhara M. 2001. Production Technology of Medicinal and Aromatic Crops. Natural Remedies Pvt. Ltd.
4. Jain SK. 2000. Medicinal Plants. National Book Trust.
5. Julia F & Charters MC. 1997. Major Medicinal Plants – Botany, Cultures and Uses. Thomas Publ.

6. Kurian A & Asha Sankar, M. 2007. Medicinal Plants. Horticulture Science Series, New India Publ. Agency.
7. Prajapati ND, Paero Hit SS, Sharma AK, Kumar T. 2006. A Hand book of Medicinal Plants. Agro Bios (India).

MINOR COURSES

HOR PG 541: PRINCIPLES OF PLANT PHYSIOLOGY

Unit I: Soil-water relationship

Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology, water potential of plant cells. Mechanism of water uptake by roots-transport in roots, aquaporins, movement of water in plants – Mycorhizal association on water uptake. Water loss from plants-Energy balance-Solar energy input-energy dissipation at crop canopy level- evapotranspiration transpiration –Driving force for transpiration, plant factors influencing transpiration rate. Stomata structure and function – mechanism of stomatal movement, antitranspirants.

Unit II: Mineral nutrition

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

Unit III: Photosynthesis

Photosynthesis and its importance in bio productivity. Photochemical process, photochemical reactions, CO2 reduction in Calvin cycle, supplementary pathway of C fixation in C4 and CAM plants and its significance. Photorespiration and its relevance. Translocation of photosynthates and its importance in sink growth. Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration and its significance. Nitrogen metabolism: Inorganic nitrogen species (N2, NO3 and NH3) and their reduction to aminoacids, protein synthesis and nucleic acids.Lipid metabolism- Storage, protective and structural lipids. Biosynthesis of fatty acids, diacyl and triacyl glycerol, fatty acids of storage lipids. Secondary metabolites and their significance in plant defence mechanism.

Unit IV: Growth regulation

Growth and differentiation. Hormonal concept of growth and differentiation, plant growth hormones and their physiological role synthetic growth regulators, growth retardants., Apical dominanace, senescence, fruit growth, abscission. Photo morphogenesis: Photo receptors, phytochrome, cryptochrome, physiology of flowering- Photoperiodism and Vernalisation.

Reading List:

1. Hopkins WG & Huner NPA. 2004. *Introduction to Plant Physiology*. John Wiley & Sons.
2. Salisbury FB & Ross C. 1992. *Plant Physiology.* 4th Ed. Wadsworth Publ.
3. Taiz L & Zeiger E. 2006. *Plant Physiology*. 4th Ed. Sinauer Associates.
4. Srivastava L.M. 2002. *Plant Growth and Development: Hormones and Environment.* Academic Press.

5. Hunt R. *Plant Growth Curve - The Fundamental Approach to Plant Growth Analysis*. Edward Arnold.
6. John H, Thornley M & Johnson IR. *Plant and Crop Modeling: A Mathematical Approach to Plant and Crop Physiology*. Blackburn Press.
7. Vos J, Marcelis LFM, Visser PHBD, Struik PC & Evers JB. (Eds.). 2007. *Functional-Structural Plant Modelling in Crop Production.* Vol. XXII. Springer.

HOR PG 542: PLANT PROTECTION FOR HORTICULTURAL CROPS

Unit I: Diseases of Horticulture Crops

Economic Importance, symptoms, cause, disease cycle and integrated management of diseases of: citrus (canker, gummosis, citrus decline) mango (malformation, anthracnose powdery mildew), banana (bunchy top, panama wilt, moko disease), grapevine (powdery mildew, downy mildew), papaya (leaf curl, mosaic, stem rot), guava (wilt), apple (scab, fire blight), chilli (anthracnose, leaf curl), brinjal (blight, wilt, little leaf), zinger (rhizome rot), colocasia (phytopthora blight), bhendi (yellow vein mosaic, leaf spot), coriander (stem gall), potato (early blight, late blight, mosaic) crucifers, (club root, black rot), cucurbits(powdery mildew, downy mildew), tomato (early blight, late blight,leaf curl, wilts), beans (yellow mosaic, anthracnose), (onion purple blotch), coconut (bud rot, stem bleeding), betelvine (phytopthora blight), coffee (rust), tea (blister blight), rose (die back, podery mildew), chrysanthemum (root rot , bacterial blight)

Unit II: Management Strategies for Vegetable Crops

Distribution, biology, nature and symptoms of damage and management strategies of following pests:

Vegetables:

Cruciferous : Cabbage semi looper, Diamond back moth, Leaf webber, Cabbage borer
Tomato : Fruit borer, Leaf miner, Stem borer
Onion & Garlic: Thrips, Tobacco caterpillar, Onion fly.
Coriander : Aphid, White fly, Flower stink bug.

Unit III: Management Strategies for Fruits

Distribution, biology, nature and symptoms of damage and management strategies of following pests:

Fruit:

Mango: Inflorescence midge, Mango shoot gall psylla, Mango hopper, Mealy bug, Stone weevil, Stem borer
Citrus: Lemon butter fly Citrus psylla, Fruit sucking moth, Whitefly, Leaf miner.
Papaya: Fruit fly, Aphid, White fly, Mite,
Ber : Ber fruit fly,
Litchi: Litchi bug, Leaf roller, White fly, Black hussain fly, Mite

Unit IV: IDM and IPM

Principles of plant disease and pest management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease and pest control, integrated control measures of plant diseases and pests. Role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.

Reading List:

1. Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 1996. Introduction to Mycology

Wiley Eastern Ltd., New York.
2. Mandahar,C.L. 1987. Introduction to Plant Viruses. Chand and Co. Pvt. Ltd., New Delhi.
3. Agrios, G.N. 2006. Plant Pathology. Elsevier Academic press, London.
4. L.R. Verma and R.C. Sharma. *Diseases of horticultural Crops*-, Indus Publishers
5. Srikant Kulkarni, Yashoda R. Hedge, *Diseases of Plantation crops and their management*- Agrotech publication Academy.
6. S.L. Godara, BBS Kapoor, B.S. Rathore *Disease management of spice crops*-, Madhu Publications.
7. Anna L *A colour atlas of Post Harvest Diseases and Disorders of fruits and vegetables* -. Snowdon, CRC Press.

HOR PG 543: PRINCIPLES OF PLANT PHYSIOLOGY- Practical

Unit I: Soil-Water Relationship

Measurement of soil water status, Measurement of plant water status, Measurement of transpiration rate, Measurement of Vapour pressure deficits, Stomatal physiology, influence of ABA on stomatal closing.

Unit II: Mineral Nutrition

Mineral nutrients: Demonstration of energy requirement for ion uptake. Deficiency symptoms of nutrients, Radiant energy measurements, separation and quantification of chlorophylls, O_2 evolution during photosynthesis,

Unit III: Photosynthesis

Measurement of gas exchange parameters, conductance, photosynthetic rate, photorespiration, Respiration rates, Estimation of reducing sugars, starch. Estimation of NO_3, free aminoacids in the xylem exudates, quantification of soluble proteins.

Unit IV: Growth Regulation

Bioassays for different growth hormones- Auxins, Gibberellins, Cytokinins, ABA and ethylene. Demonstration of photoperiodic response of plants in terms of flowering.

Reading List:

1. Hopkins WG & Huner NPA. 2004. *Introduction to Plant Physiology*. John Wiley & Sons.
2. Salisbury FB & Ross C. 1992. *Plant Physiology.* 4th Ed. Wadsworth Publ.
3. Taiz L & Zeiger E. 2006. *Plant Physiology*. 4th Ed. Sinauer Associates.
4. Srivastava L.M. 2002. *Plant Growth and Development: Hormones and Environment.* Academic Press.
5. Hunt R. *Plant Growth Curve - The Fundamental Approach to Plant Growth Analysis*. Edward Arnold.
6. John H, Thornley M & Johnson IR. *Plant and Crop Modeling: A Mathematical Approach to Plant and Crop Physiology*. Blackburn Press.
7. Vos J, Marcelis LFM, Visser PHBD, Struik PC & Evers JB. (Eds.). 2007. *Functional-Structural Plant Modelling in Crop Production.* Vol. XXII. Springer.

HOR PG 544: PLANT PROTECTION FOR HORTICULTURAL CROPS -Practical

Unit I: Diseases of vegetables and flowers

Diseases of chilli, brinjal&bhendi;
Diseases of potato, tomato & crucifers;
Diseases of cucurbits, onion &betelvine;
Diseases of rose, chrysanthemum.
Field visits at appropriate time during the semester.

Unit II: Diseases of fruits

Diseases of citrus, guava, &sapota; Diseases of papaya, banana, pomegranate &ber; Diseases of mango, grapes & apple;Diseases of oil palm, coconut, tea, coffee;Field visits at appropriate time during the semester.

Unit III: IDM

Application of biological, cultural, chemical and bio control agents, their compatibility and integration in IDM. Study of structural details of sprayers and dusters

Unit IV: IPM

Identification of pests, their damage symptoms and management of the crops mentioned under theory. Collection and preservation of pests and their damaged materials.

Reading List:

1. Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 1996. Introduction to Mycology Wiley Eastern Ltd., New York.
2. Mandahar,C.L. 1987. Introduction to Plant Viruses. Chand and Co. Pvt. Ltd., New Delhi.
3. Agrios, G.N. 2006. Plant Pathology. Elsevier Academic press, London.
4. L.R. Verma and R.C. Sharma. *Diseases of horticultural Crops*-, Indus Publishers
5. Srikant Kulkarni, Yashoda R. Hedge, *Diseases of Plantation crops and their management*- Agrotech publication Academy.
6. S.L. Godara, BBS Kapoor, B.S. Rathore *Disease management of spice crops*-, Madhu Publications.
7. Anna L *A colour atlas of Post Harvest Diseases and Disorders of fruits and vegetables* -. Snowdon, CRC Press.

COMPULSORY COURSE

HOR PG 551: Growth and Development Studies and Biotechnological Application

Unit I: Growth and Development in Horticultural crops

Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.Annual,semi-perennial and perennial horticultural crops, environmental impacton growthanddevelopment,effectoflight,photosynthesisand photo-periodismvernalisation, effect of temperature, heat units, thermo-

periodism.Assimilatepartitioningduringgrowthanddevelopment,influenceofwater andmineral nutritionduringgrowthanddevelopment, biosynthesisof auxins,gibberellins,cytokinins,abscissicacid,ethylene,brasssinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors.Developmental physiology and biochemistry during dormancy, bud break, juvenility,vegetative to reproductive inter-phase, flowering, pollination,fertilizationandfruitset,fruit drop, fruitgrowth,ripening and seed development.Growthanddevelopmentalprocessduringstress-manipulationofgrowth anddevelopment,impactofpruningandtraining,chemicalmanipulations inhorticultural crops,molecularandgeneticapproachesinplantgrowth development.

Unit II: Tissue Culture and Molecular Markers

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.).

Unit III: Molecular Mapping and genomics

Mapping populations (F2s, back crosses, RILs, NILs and DH).Molecular mapping and tagging of agronomically important traits.Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

Unit IV: r- DNA Technology

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various horticultural crops and Commercial releases.Biotechnology applications in male sterility/hybrid breeding, molecular farming.MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights.Bioinformatics& Bioinformatics tools.Nanotechnology and its applications in crop improvement programmes.

Reading List:

1. Buchanan B, Gruiessam W & Jones R. 2002. Biochemistry & Molecular Biology of Plants. John Wiley & Sons.
2. Fosket DE. 1994. Plant Growth and Development: A Molecular Approach. Academic Press.
3. Leoplod AC & Kriedermann PE. 1985. Plant Growth and Development. 3rd Ed. McGraw-Hill.
4. Chadha KL, Ravindran PN & Sahijram L. (Eds.). 2000. Biotechnology of Horticulture and Plantation Crops. Malhotra Publ. House.
5. Debnath M. 2005. Tools and Techniques of Biotechnology. Pointer Publ.
6. Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene*

Transfer. Orient & Longman, Universal Press.
7. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.

HOR PG- 552: Protected cultivation and Post-Harvest Technology

Unit I: Introduction to protected cultivation and protected structure

Greenhouse – World scenario, Indian situation: present and future, Different agro-climatic zones in India, Environmental factors and their effects on plant growth.Basicsofgreenhousedesign,differenttypesofstructures–glasshouse, shadenet,polytunnels-Designanddevelopmentoflowcostgreenhouse structures.

Unit II: Regulation of environmental parameters in Greenhouse

Interaction oflight,temperature,humidity,CO_2wateroncropregulation- Greenhouseheating,cooling, ventilation and shading.Typesof ventilation-Forcedcooling techniques-Glazingmaterials -Micro irrigation and Fertigation.Automated greenhouses, microcontrollers, waste water recycling, Management of pest and diseases – IPM.

Unit III: Post harvest physiology of horticultural crops

Maturity indices, harvesting practices for specific market requirements,influence of pre-harvest practices, enzymatic and textural changes,respiration, transpiration.Physiology and biochemistry of fruit ripening, ethylene evolution andethylenemanagement, factors leading to post-harvest loss, pre-cooling.

Unit IV: Post Harvest handling and processing

Treatments prior to shipment, viz., chlorination, waxing, chemicals,biocontrolagents and natural plant products. Methods of storage-ventilated, refrigerated, MAS, CA storage, physical injuries and disorders.Packing methods and transport, principles and methods of preservation,food processing, canning, fruit juices, beverages, pickles, jam, jellies,candies.Dried and dehydrated products, nutritionally enriched products, fermentedfruit beverages, packaging technology, processing waste management, foodsafety standards.

Reading List:

1. Haid NF & Salunkhe SK. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ.
2. Mitra SK. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits*. CABI.
3. Ranganna S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.
4. Sudheer KP & Indira V. 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.
5. Pant V Nelson. 1991. *Green House Operation and Management*. Bali Publ.
6. Pradeep kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2007. *Management of Horticultural Crops.* Parts I, II. New India Publ. Agency.
7. Aldrich RA & Bartok JW. 1994. *Green House Engineering*. NRAES, Riley, Robb Hall, Cornell University, Ithaca, New York.

HOR PG 553: Experimental Design

Unit I: Basic Principles of Experimental Design
Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control.Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

Unit II: Types of Design
Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surface Methodology.Experiments with mixtures.

Unit III: Factorial design and confounding
Factorial experiments, (symmetrical as well as asymmetrical). Orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

Unit IV: Bioassay
Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.

Reading List:

1. Chandel S.R.S., 1990. A Handbook of Agricultural Statistics, Achal Prakashan Mandir, Kanpur
2. Gomez K.A. and Gomez A.A., 1984. Statistical Procedures for Agricultural Research, Wiley Publications
3. Panse V.G. and Sukhatme P.V. , Statistical Methods for Agricultural Workers, ICAR, New Delhi
4. Goon, A.M, Gupta, M.K & Dasgupta, B. *Basic Statistics,* World Press Pvt. Ltd.
5. Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan chand and sons. New Delhi
6. NageswaraRao,G. 2007.*Statisticsfor AgriculturalSciences*. BSPublications,Hyderabad.
7. Rangaswamy,R. 1995. *ATextBookofAgriculturalStatistics*. NewAgeInternationalPublishingLimited, Hyderabad.

HOR PG 554: IPR, Research Ethics and Disaster Management

Unit I: Intellectual Property Rights
Historical perspectives and need for the introduction of Intellectual PropertyRightregime;TRIPsandvariousprovisionsinTRIPSAgreement; Intellectual Property and IntellectualProperty Rights (IPR), benefits of securingIPRs;IndianLegislations fortheprotectionofvarioustypesof IntellectualProperties;Fundamentalsofpatents, copyrights,geographical indications,designsandlayout,tradesecrets andtraditional knowledge, trademarks, protection of plant

varieties and farmers' rights and bio- diversity protection; Protectable subjectmatters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; ConventiononBiologicalDiversity;InternationalTreatyonPlantGenetic ResourcesforFoodand Agriculture;Licensingoftechnologies, Material transfer agreements, ResearchCollaboration, Agreement, License Agreement.

Unit II: National Agriculture Research System

Historyofagricultureinbrief;Globalagriculturalresearchsystem:need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural ResearchCentres(IARC),partnershipwithNARS,roleasapartnerintheglobalagriculturalresearchsystem,strengtheningcapacities at national and regional levels; International fellowships for scientific mobility.

Unit III: Research Ethics

Researchethics:researchintegrity,researchsafetyinlaboratories,welfare ofanimals usedinresearch,computerethics,standardsandproblemsin research ethics.Conceptandconnotations of ruraldevelopment,ruraldevelopmentpolicies andstrategies.Ruraldevelopmentprogrammes:CommunityDevelopment Programme, IntensiveAgriculturalDistrictProgramme,Specialgroup– Area Specific Programme, Integrated Rural Development Programme (IRDP) PanchayatiRajInstitutions, Co-operatives, Voluntary Agencies/Non-GovernmentalOrganisations. Critical evaluationof rural developmentpoliciesandprogrammes.Constraintsin implementation of rural policies and programmes.

Unit IV: Disaster Management

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

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

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

Reading List:

1. Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
2. Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. *Technology Generation and IPR Issues*. Academic Foundation.
3. Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.
4. Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
5. Singh K.. 1998. *Rural Development - Principles, Policies and Management.* Sage Publ.

6. Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.
7. Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.

HOR PG 555: Growth & Development, Biotechnology, PHT and Protected cultivation-Practical

Unit I: Growth and Development

Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs, visit to arid, subtropical and temperatehorticulturalzonestoidentifygrowthanddevelopmentpatterns, techniques of growth analysis, evaluation of photosynthetic efficiency under different environments, study of growth regulator functions, hormone assays, understanding ripening phenomenon in fruits and vegetables, study of impact of physical manipulations on growth and development,studyofchemicalmanipulationsongrowthanddevelopment, understanding stress impact on growth and development.

Unit II: Tissue Culture and Molecular Markers

Requirements for plant tissue culture laboratory-Techniques in plant tissue culture - Media components and media preparation -Aseptic manipulation of various explants ; observations on the contaminants occurring in media – interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit. Transformation using Agrobacterium strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

Unit III: **Protected Cultivation**

Designsofgreenhouse,lowcostpolytunnels,nethouse-Regulationof light, temperature, humidity in greenhouses, media, greenhouse cooling systems, ventilation systems, fertigationsystems, special management practices, project preparation forgreenhouses, visit to greenhouses.

Unit IV: Post Harvest Technology of Horticultural crops

Analyzing maturity stages of commercially important horticultural crops,improved packing and storage of important horticultural commodities,physiological loss in weight of fruits and vegetables, estimation oftranspiration, respiration rate, ethylene release and study of vase lifeextension in cut flower using chemicals, estimation of qualitycharacteristics in stored fruits and vegetables, cold chain management -visit to cold storage and CA storage units, visit to fruit and vegetableprocessingunits,project preparation, evaluation of processed horticulturalproducts.

Reading List:

1. Leoplod AC & Kriedermann PE. 1985. Plant Growth and Development. 3rd Ed. McGraw-Hill.
2. Debnath M. 2005. Tools and Techniques of Biotechnology. Pointer Publ.
3. Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene*

Transfer. Orient & Longman, Universal Press.
4. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.
5. Sudheer KP & Indira V. 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.
6. Pant V Nelson. 1991. *Green House Operation and Management*. Bali Publ.
7. Pradeep kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2007. *Management of Horticultural Crops.* Parts I, II. New India Publ. Agency.

HOR PG 556: Library Sciences, Technical Writing and Seminar- Practical

Unit I: Library Science

Introductionto library and its services; Role of libraries in education, research andtechnologytransfer;Classificationsystemsandorganization oflibrary;Sourcesof information-PrimarySources,SecondarySources and Tertiary Sources; Intricacies of abstracting and indexing services (ScienceCitationIndex,BiologicalAbstracts, ChemicalAbstracts,CABI Abstracts, etc.); Tracing information from reference sources; Literature survey;Citationtechniques/Preparationofbibliography;UseofCD-ROM Databases,OnlinePublicAccessCatalogueandothercomputerizedlibraryservices;UseofInternetincludingsearchenginesanditsresources;e-resourcesaccess methods.

Unit II: Technical Writing

Variousformsofscientificwritings-theses,technical papers, reviews, manuals, etc; Various parts of thesis and researchcommunications(title page, authorshipcontents page, preface,introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonlyusedabbreviationsinthethesesandresearchcommunications; illustrations,photographsanddrawingswithsuitablecaptions;pagination, numberingoftablesandillustrations;Writingof numbers anddatesin scientific write-ups; Editing and proof-reading; Writing of a review article.

Unit III: Essential Laboratory Techniques

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micro pipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals.Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, and bath, water bath, oil bath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viabilitytesting,testingofpollenviability; Tissue culture of crop plants; Description off lowering plants in botanical terms in relation to taxonomy

Unit IV: Masters Seminar

Student will present one open seminar on recent advances in the horticultural technology.

Reading List:

1. *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
2. Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.

3. James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
4. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
5. Richard WS. 1969. *Technical Writing*. Barnes & Noble.
6. Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
7. Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.