LECTURE OUTLINES

B.SC. (HONS.) HORTICULTURE

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DEPARTMENT OF FRUIT SCIENCE

FRSC 1.1.1 FUNDAMENTALS OF HORTICULTURE 3(2+1)

THEORY:

1. Definition of Horticulture, importance in terms of economy, production, employment generation, environmental protection and human resource development. Scope of Horticulture in India, Classification of horticultural crops.
2 & 3. Nutritive value of horticultural crops, Divisions of horticulture with suitable examples and their importance, area, production, exports and imports of horticultural crops.
4& 5. Horticultural zones of India and Telangana, Fruit and vegetable zones of India and and of different states. Horticultural research stations in Telangana and National level horticultural research stations in India.
6 &7. Definition of Nursery, different types of nursery beds, their merits and demerits, Nursery techniques and their management, soil and climate.
8. Vegetable gardens, nutrition and kitchen garden and truck garden, vegetable forcing, market garden & roof gardens.
9. Establishment of orchards- Principles, planning and layout, management of orchards.
10 & 11. Planting Systems- Square, rectangle, quincunx, hexagonal, contour system of planting and calculation of planting densities in different systems of planting.
12. Pruning –Definition of pruning, objectives, principles, methods of pruning of fruit crops.
13&14. Training –Definition of training, objectives, principles, methods of training of fruit crops.
15. Types and use of growth regulators in horticulture.
16&17. Water management– Definition of Irrigation, different methods of irrigation followed in Horticultural crops, merits and demerits.
18. Weed management, definition, types of weedicides, and weeds in horticulture crops.
19&20. Fertility management in horticultural crops-definition of manures and Fertilizers, different methods of application of manures and fertilizers to Horticultural crops
21&22. Cropping systems, intercropping, multi-tier cropping, merits and demerits with suitable examples.
23. Mulching– definition of mulch, objectives of mulching, types-organic and Inorganic mulches, merits and demerits.
24. Bearing habits of fruit trees.
25&26. Factors influencing the fruitfulness and unfruitfulness with suitable examples.
27. Rejuvenation of old orchards, top working, frame working.
28. Principles of organic farming, importance, advantages and disadvantages.
29 Maturity – definition of maturity, different methods of judging maturity & Maturity indices of horticultural crops.
30&31. Harvesting, transport grading, packing and storage, market chain management of horticultural crops.
32. Principles of precision farming.

PRACTICALS:

1. Study of tools and implements used in horticulture crops.
2. Identification of various horticultural crops.
3. Study of features of orchard.
4. Layout of different planting systems

5. Layout of nutrition garden.
6. Preparation of nursery beds for sowing of vegetable seeds.
7. Digging of pits for fruit plants and study of planting systems
8. Study of different methods of Training
9. Study of different methods of Pruning
10. Preparation of fertilizer mixtures and field application.
11. Preparation and application of growth regulators.
12. Layout of different irrigation systems.
13. Identification and management of nutritional disorder in fruits and Vegetables.
14. Study of bearing habits in horticultural crops.
15. Study of Maturity standards and harvesting of important fruits and vegetables.
16. Study of grading, packaging and storage of fruits and vegetables.

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- K.V.Peter, 2009. *Basics Horticulture.* New India Publishing Agency
- Kausal Kumar Misra and Rajesh Kumar, 2014. *Fundamentals of Horticulture* Biotech Books.
- D.K. Salunkhe and S.S. Kadam, 2013. *A handbook of Fruit Science and Technology*. CRC Press.
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FRSC-1.1.2 PLANT PROPAGATION AND NURSERY MANAGEMENT 2(1+1)

THEORY:

1. Propagation: Need and potentialities for plant multiplication, sexual and asexualmethods of propagation, advantages and disadvantages.
2. Seed dormancy - types of dormancy (scarification& stratification) internal and external factors. Use of growth regulators in seed, types and stages of seed germination with Examples.
3. Nursery techniques, nursery management, apomixes – mono-embryony, polyembryony, chimera& bud sport; nursery tools and implements.
4. Propagation Structures: Mist chamber, humidifier, greenhouses, glasshouses, cold frames, hot beds, poly-housesand phytotrons.
5. Vegetative propagation, methods and techniques of division-stolons, pseudobulbs, offsets, runners.

6&7. Methods and techniques ofCuttings- Hardwood, Semihard wood, Herbaceous, softwood cuttings, Physiological & bio chemical basis of rooting, factors influencing rooting of cuttings.

8. Layering- types, establishment of layers in the field; physiological & biochemical basis of rooting, factors influencing rooting of layering.

9&10. Grafting– Approach grafting, Veneer grafting, Wedge grafting, Saddle grafting, Tongue grafting, Whip grafting, Bridge grafting, Epicotyl grafting, Softwood grafting. Formation of graft union, factor affecting, healingof graftageand Graftingcompatibility (localized and translocated).

11. Budding- T- budding inverted T-budding, Shield budding, Chip budding, Flute budding, Ring budding, I-budding.
12. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, scion-stock relationship, and their influences, bud wood certification, techniques of propagation through specialized organs.

13&14. Micrografting, meristem culture, callus culture, anther culture, organogenesis, somaclonal variation, hardening of plants in nurseries.

15. Nursery registration act. Pest/disease control in nursery.
16. Cost of establishment of propagation structures. Establishment of nursery (planning, design, layout & cost).

PRACTICALS:

1. Media –Types of media and characteristics and preparation of potting mixture and soil sterilization. Potting and repotting.
2. Preparation of nursery beds and sowing of seeds.
3. Raising of rootstocks.
4. Seed treatments for breaking dormancy and inducing vigorous seedling growth.
5. Preparation of plant material for potting.
6. Hardeningof plants in the nursery.
7. Study and practicing of different types of propagation by cuttings and layering.
8. Study and practicing of different propagation by grafting and budding including opacity and grafting, top grafting bridge grafting etc.
9. Use of mist chamber in propagation and hardening of plants.
10. Preparation of plant growth regulators for seed germination and vegetative propagation.

11. Digging, labelling and packing of nursery fruit plants.
12. Maintenance of nursery records.
13. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery.
14. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance.
15. Nutrient and plant protection applications in nursery.
16. Identification and use of equipment in tissue culture laboratory and visit to tissue culture lab.

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- S. Rajan and B. L. Markose (series editor Prof. K.V.Peter). *Propagation of Horticultural Crops- Horticulture Science Series vol.6.* New India Publishing Agency, Pitam Pura, New Delhi-110088.
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- Vinod kumar, nursery and plantation practices in forestry. Scientific publishers.
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FRSC-2.1.1 TROPICAL AND SUB-TROPICAL FRUITS 3(2+1)

THEORY:

1. Horticultural classification of fruits including genome classification & Horticultural zones of India
2. Mango: Introduction & History, Nutritive Value, Uses, Origin & Distribution Area and Production, Export Potential, Importing Countries, Important Species of Mango Production Technology: Climatic requirements –Temperature, rainfall and other requirements for optimum vegetative growth, flowering, and fruit development under North Indian and South Indian conditions Soil requirements.
3. Mango Varieties: Indian and Exotic varieties – Varieties suitable for export, Commercial varieties – Table varieties, Juicy varieties, Table and Juicy Varieties, Pickle Varieties, Varieties suitable for Preservation, Early, Late and. Off-Season Varieties, Mono &Polyembroynic, Varieties suitable for different regions of Telangana and Varieties/Hybrids of Mango released for cultivation in of North, South, East and West parts in all over India.
4. Propagation: Commercial propagation by Epicotyl grafting, Veneer grafting planting Density; Training and pruning, High Density Planting system. Nutritional and Irrigation requirement; Role of Major & Minor nutrients, Inter cultivation; Intercropping, Weed management.
5. Special Horticultural Practices: Manipulation of flowering through canopy management & application of plant growth regulators, Flowering: Environmental factors influencing flowering, types of flowers, agents of pollination, fruit set, fruit drop and its control.
6. Alternate Bearing / Biennial Bearing: Causes and control measures. Physiological Disorders & their control: Malformation (Vegetative & Floral), Black Tip, Spongy Tissue, and leaf Scorch. Harvesting & Yield: Harvest Indices, Methods of Harvesting, Grading, Packing, Transport, Storage and Ripening
7. Banana and Plantains: Economic importance – Nutritive value, Uses, Origin of various groups & Distribution, Area & Production,export potential; Genomic classification and Nomenclature; Taxonomic Classification: Musa acuminate, Musa bulbisiana Major genomic groups and Cultivars in the World and Hybrids.
8. Production Technology: Climate, Soil requirements. Propagation by Suckers, Treatment of suckers before planting; Micro propagation: Planting density Irrigation, Nutritional requirements.
9. Management of Banana crop: Desuckering, Ratoon sucker selection, Weed control, Mulching, Earthing up. Leaf removal, Provision of Wind breaks; Bunch management: Propping of bunches, Wrapping, Trimming, Removal of Male bud, Bunch covering. Harvesting indices in Banana, Harvesting, Yield, Ripening and Storage Physiological Disorders: 1) Chilling injury 2) Choke throat 3) Seediness 4) kokkan disease
10. Citrus: Introduction and History, Economic importance, Nutritive value, Uses, Origin & Distribution, Area & Production and Export Potential, classification of Citrus: I. Swingle Classification (1948)Eucitrus (10) and Papeda (6) :II. Tanaka Classification (1954). III. Hodgsons Classification: Acid members, Oranges, Mandarins, Pummelos and Hybrids of Citrus
11. Production Technology: Climatic & Soil requirements of important citrus groups Varieties: Indian and Exotic varieties of Sweet Oranges, Mandarins, Grape Fruit and Pummelo, Lemons, Limes Propagation: Seedling stocks, Root stocks tolerant to

diseases, Stock & Scion relationship, methods of propagation -Bud Wood Certification – Virus free bud wood, Nucellar clones, Virus indicator species.

12. Planting Densities, Irrigation, Root Stocks, Age & Bearing Capacity; Nutrient management: Major & Minor nutrients, Deficiencies, Weed Management; Training and Pruning of young, pre bearing plants, and bearing trees, Root pruning and Bahar Treatment (Ambebahar, Mrigbahar and Hasthbahar)
13. Flowering: Factors effecting fruit set, Fruit drop and its control, Physiological Disorders like Granulation, and Rind pitting; Citrus Decline: Symptoms, Factors responsible and Control measures. Harvesting: Maturity Indices, Yield of fruits, Post Harvest Handling: Grading, Packing, Transport, Storage and Ripening.
14. Grapes: Economic importance, Nutritive value, Uses, Origin & Distribution, Area &Production, export potential; Genera, and Species grown in different regions of the World; Varieties:Indian and Exotic Varieties–Seeded & Seedless Varieties, Coloured varieties, Varieties suitable for table, wine, Juice, Canning and raisin purpose.
15. Production Technology: Climatic requirements, Soil requirements, Propagation, Method of propagation of root stocks, Planting Density, Planting, Irrigation, Nutrition: role of Major & Minor nutrients, Fertilizer Scheduling.
16. Training: Purpose, systems of training (Bower, telephone system, Trellis system-T and Y, vertical cordon system – single & double, kniffin system, Gable system) Pruning: Objectives, Definitions of Cane, Spur, Soot, Fruiting Spur, Foundation Spur, / Renewal Spur, Long Spur, Medium Spur, Arms, Trunk, Suckers etc., Pruning for vegetative growth (summer) and for fruiting (winter), Level of pruning, Bud forecasting.
17. Improvement of yield through practices like girdling, pinching thinning of flowering and berry drop. Fruit set, Stenospermocarpy, Stages of berry growth; Use of plant growth regulators to induce Seedlessness, Improve quality and for crop regulation. Maturity Standards, Harvesting & Yield, Grading, Packing, Storage and Ripening; Physiological Disorders- Blossom end rot, Intervenalchlorosis, Poor Bud Burst, flower and Berry drop, Barrenness of vine, Pink berry, Cracking of Rachis, shot berry, Hen & Chicken disorder.
18. Sapota : Economic Importance, Nutritive value, Origin & Distribution, Area &Production, export potential; Species & Types: Types based on growing habit (Erect, Drooping and Spreading), Varieties and hybrids; Production Technology: Climatic & Soil requirements; Propagation, Root Stocks, Planting Density, methods of irrigation, nutrient management, Interculture, weed management and inter-cropping, Maturity Indices, Harvesting, Yield, post harvestandling, Grading, Packing, Transport, Marketing, Ripening and Storage.
19. Guava: Economic Importance, Nutritive value, Origin & Distribution, Area & Production, export potential; Speincies& Varieties (Indian & Exotic), Hybrids; Production Technology: Soil & Climatic requirements, propagation by Vegetative methods (Air layering, Ground layering and Stooling); Planting, Planting density, Irrigation, Nutrient management, training and pruning. Bahar treatment (Ambebahar, Mrigbahar and Hasta bahar), Flowering, Plant Growth Regulators for Fruit thinning, and Parthenocarpy; Maturity Indices, Harvesting, post harvest handling, Yield, Packing, Transportation, and Storage
20. Papaya: Economic Importance, Nutritive value, Origin & Distribution, Area &Production,export potential; Varieties: (Pusa varieties, Coimbatore varieties, Taiwan varieties etc.); Sex expression and Sex identification. Production Technology: Soil & Climatic requirements, Propagation, Seed production, Planting, Irrigation & Nutrient management.

21. Maturity indices, Harvesting, Yield, post harvest management and Storage. Latex extraction: Papain: Classification, uses, Factors effecting Papain Production, Suitable varieties for Papain, Extraction & Yield of Papain, Marketing & Prospects.
22. Pine Apple: Economic Importance, Nutritive value, Origin & Distribution, Area & Production, export potential, Varieties: Groups: Spanish, Abacaxi, Queen, Cayene, MaiporeProduction Technology: Soil & Climatic requirements; Propagation by shoot suckers, Ground suckers, slips, crowns, stumps, micro propagation, High Density Planting, Water and Nutrient management, Interculture, flowering and fruiting. Use of chemicals and plant growth regulators for improving the flowering and fruiting, Maturity indices, Harvesting for local market and Distant markets Yield, Post harvest handling and storage.
23. Pomegranate: Economic importance, nutritive value, origin and distribution, Area and Production, export potential, Varieties: Hard seeded and soft seeded. Production technology: Soil & climatic requirements; Propagation, Planting, Training and Pruning, Irrigation, Nutrient Management, Bahar treatment, Flowering, flower and Fruit thinning, Harvest indices, Yield, post harvest management and storage. Physiological disorders.
24. Custard Apple: Economic Importance, Nutritive value, Origin & Distribution, Area & Production, export potential,*Annonasquamosa*, *A. muricata*, *A. reticulate*, *A.cherimola*, Atemoya Hybrid; Varieties & Groups – Green fruit & Red fruit; Production Technology: Soil and Climate; Propagation: Seed, Vegetative Propagation, Planting density; Irrigation & Nutrient management, Flowering time, Fruit Development, maturity indices, Harvesting, Yield, Post harvest management and Storage.
25. Ber: Economic Importance, Nutritive value, Origin & Distribution, Area & Production, export potential, species& varieties; Adaptive features of Ber, Production technology: Soil & climatic requirements; Training and Pruning, irrigation and nutrient management; Flowering & fruit set, Fruit drop and its control, maturity indices, yield.
26. Fig: Economic Importance, Nutritive value, Origin & Distribution, Area & Production, export potential types& varieties (Capri fig, Adriatic fig, Smyrna fig and sanpedro fig) Production technology: Soil & climatic requirements; Training and Pruning, irrigation and nutrient management; Flowering & fruit set, caprification, maturity indices, yield. Post harvest management, Storage and physiological disorders.
27. Litchi: Economic Importance, Nutritive value, Origin & Distribution, Area & Production, export potential, Species & varieties: Exotic / Indian Varieties-Early, Mid-season and Late season varieties; Production technology: Soil and climatic requirements; propagation, Nutrient Management, Irrigation, Interculture, flowering and fruiting, fruit drop and its control; Maturity indices, Harvesting, yield, Post Harvest handling and Storage; Regulation of colour break in litchi, Physiological disorders: Fruit cracking
28. Rambutan: Economic Importance, Nutritive value, Origin & Distribution, Area &Production, export potential, Exotic varieties, Propagation, Planting density, Nutrient Management, Flowering, Harvesting and Yield.

    Jack Fruit: Economic Importance, Nutritive value, Origin & Distribution, Area & Production, Species and cultivars of Jack fruit (India, Exotic). Production technology Soil & climatic requirements, propagation, planting, Irrigation, nutrition, flowering, fruitset, maturity indices, harvesting and yield.

29. Avocado: Economic importance, nutritive value, Origin & Distribution, Area &Production, export potential; Species and Varieties: Different Races-Mexican, Guatemalan and West Indian races, Cultivars of three races, production technology: Soil and Climatic requirements; propagation, density, planting, pruning; Irrigation, Nutrition, Flowering and Fruiting: Diurnally Synchronous Dichogamy; Maturity indices, Harvesting, Yield, Post harvest management and Storage.
30. Passion Fruit: Economic Importance, Nutritive value, Origin & Distribution, Area &Production; export potential, Species & Cultivars (Purple, Golden yellow, Hybrid (kavery), Noel's special), Soil, Climate, Propagation, Irrigation, Flowering, Fruiting, fruit set, Maturity indices, Harvesting, Yield and Storage.
31. Durian, Bael, Carambola, Mangosteen, Aonla: Economic Importance, Nutritive value, Origin & Distribution, Area Production; export potential, important Species & Cultivars, Production technology- Soil, climate, Propagation, flowering, fruiting, Harvesting and Yield.
32. Bilimbi, Loquat, Rose apple, Breadfruit: Economic Importance, Nutritive value, Origin & Distribution, Area Production; export potential, important Species & Cultivars, Production technologyProduction technology- Soil, climate, Propagation, flowering, fruiting, Harvesting and Yield.

PRACTICALS:

1. Description and identification of varieties of Mango based on Fruit morphology.
2. Description and identification of varieties of Banana .
3. Description and identification of varieties of Grape
4. Description and identification of varieties of Citrus.
5. Description and identification of varieties of Papaya Seed production in Papaya, latex extraction and preparation of crude papain, Study of sex forms in Papaya
6. Description and identification of varieties of Guava, Sapota, and pine apple.
7. Description and identification of varieties of Avocado, Litchi, Jack fruit,
8. Description and identification of varieties of passion fruit Carambola, Durian and Mangosteen.
9. Description and identification of varieties of Pomegranate, Ber and Aonla.
10. Description and identification of varieties of Annona, Jamun, Wood apple, Bael, Carissa.
11. Description and identification of varieties ofFig, Phalsa, Date-Palm, Tamarind and West Indian Cherry.
12. Training and Pruning of Mango, Grapes, Guava and Citrus.
13. Use of plastics in fruit production viz., in propagation, mulching, irrigation, Packaging, storage etc.
14. Mapping of arid and semi-arid zones of Indiaand Visit to commercial orchards and diagnosis of maladies (Nutrient deficiencies, Pest & Diseases, Physiological disorders etc.)
15. Manure & Fertilizer application including Bio-fertilizers in different fruit crops (Methods of application, calculation of the required Manure & Fertilizers based on the nutrient content).
16. Ripening of fruits, grading & packaging and production economics for tropical and sub-tropical fruits.

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- W S Dhillon, 2013. *Fruit Productionin India.* Narendra Publishing House, New Delhi
- T.K.Chattopadhyay, 1997. *Text book on pomology*. Kalyani Publishers, New Delhi.
- R.E.Litz, 2009. *The Mango* 2nd Edn. Cabi Publishing, Willingford, U.K.
- K.L.Chadda, 2009. *Advanced in Horticulture*. Malhotra Publishing House, New Delhi.
- S.P. Singh, 2004. *Commercial fruits.* Kalyani Publishers, New Delhi.
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FRSC 2.1.2 TEMPERATE FRUIT CROPS 2(1+1)

THEORY:

1. Definition of temperate region, climatic conditions of temperate zone, Classification of temperate fruits.
2. Apple: Introduction, origin, and distribution, composition and uses, area, production, varieties, climate and soil requirements, root stocks (Dwarf, Semi-dwarf, Vigorous root stocks, M-Series and MM- Series root stocks), Propagation, planting methods, Training & Pruning methods of Apple.
3. Manures and fertilizers and After care, Flowering, Induction of early flowering, use of growth regulators in flowering, Pre harvest drop, Blossom and fruit thinning.
4. Factors effecting colour development, Harvesting, Different maturity indices, Post-harvest handling, Grades followed in India, storage and physiological disorders of apple.
5. Pear: Introduction, centers of origin, and distribution, different species of pear composition and uses, area, production, varieties, climate and soil requirements, rootstocks, propagation, Training & pruning of pear
6. Manures and fertilizers, Intercropping, flowering and fruiting and use of growth regulators, harvesting, maturity indices, post -harvest handling and storage of Pear.
7. Peach: Introduction, origin, and distribution, varieties, Composition and uses, different species of peach, area, production, climate and soil requirements, rootstocks, propagation, Training & pruning of peach.
8. Manures and fertilizers, Intercropping, flowering and different stages of stone fruit growth and stages of maturity, maturity indices, harvesting, post-harvest handling and storage and physiological disorders of Peach.
9. Apricot: Introduction, origin, and distribution, varieties, composition and uses, different species of Apricot, area, production, climate and soil requirements, root stocks, propagation, Training & pruning of young trees, bearing trees and rejuvenation of old Apricot trees.
10. Manures and fertilizers, flowering, pollination and fruit set, maturity indices, harvesting, post-harvest handling and storage of Apricot.
11. Plum: Introduction, origin, and distribution, varieties, composition and uses, difference between European plums and Japanese plums, Types of European plums, area, production, climate and soil requirements, root stocks, propagation, Manures and fertilizers, Training & pruning, flowering, pollination and fruit set, maturity indices, harvesting, post-harvest handling and storage of Plum.
12. Strawberry: Introduction, origin, and distribution, varieties, composition and uses, Ploidy series, climate and soil requirements, Vegetative propagation, rising of runners.
13. Different systems of planting, Matted rows, spaced beds and Hill system Mulching, Flowering (June/Ever/day neutral bearers), pollination, defoliation and deblossoming operation, Fruit set, Harvesting and Post harvest management and Physiological disorder (Albinism) in Strawberry.
14. Almond: Introduction, origin, and distribution, varieties, composition and uses, area, production, climate and soil requirements, root stocks, propagation, Manures and fertilizers, Training & pruning, flowering, pollination and fruit set, maturity indices, harvesting (mechanical), post-harvest handling and storage, Kernel use, shelling yield, grades of kernels for the international trade.
15. Introduction, origin, and distribution, composition and brief production technology of Minor temperate fruit and nut crops viz., cherry, walnut, persimmon, kiwi, queens land nut (Macadamia nut), pecan nut, hazel nut and chest nut.

16. Re-planting problems, rejuvenation and special production problems like pre-mature leaf fall, unfruitfulness, alternate bearing, control of pre-harvest fruit drop, physiological disorders, important insect pests and diseases and their control.

PRACTICALS:

1. Study of Nursery management practices
2. Description and identification of varieties of apple
3. Planting systems and Root stock characteristics of Apple
4. Description and identification of varieties of pear
5. Description and identification of varieties of peach
6. Description and identification of varieties of plum
7. Training and Pruning methods followed in apple, Pear, peach and plum
8. Manuring and fertilization of Apple, Pear, Peach, and Plum
9. Use of growth regulators in flowering of Temperate fruit crops
10. Description and identification of varieties of apricot and almond
11. Description and identification of varieties of strawberry and cherry
12. Description and identification of varieties of Kiwi and persimmon
13. Description and identification of varieties of walnut and pecan nut
14. Description and identification of varieties of hazel nut, chestnut and queens land nut.
15. Working out economics for apple, pear, plum and peach.
16. Visit to private orchards to diagnose maladies.

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FRSC-3.1.1 ORCHARD AND ESTATE MANAGEMENT 2(1+1)

THEORY:

1. Definition of Orchard and Estate – Objectives of orchard and estate management – Importance of orchard and estate management – Soil Management – Basic principles – Methods of soil management.
2. Clean cultivation by–Ploughing–Application of weedicides–Mud plastering–Merits and Demerits; Sod culture – Characteristics of ideal sod – methods of growing; Types of sod culture – Sod culture method – Sod pasture method – Sod mulch method – Temporary sod – Merits and Demerits
3. Weed management in orchards – Cultural - Mechanical methods – Biological methods – Chemical methods, Guidelines for using Herbicides in orchards, Herbicides used for weed control in the orchards.
4. Mulching in orchards – Definition of Mulch and Mulching – Objectives of Mulching; Types of Mulches – Organic mulches – Garden compost – Peat – Leaves and leafmould – Straw and Hay – Saw dust and Wood chopping – Husk – Flax – Hop waste– Pine needles - News paper and Card board; Inorganic mulches – Plastic mulch– Clear and black plastic – Coloured Plastic mulches – Dust mulches – Gravel – Stones – Sand; Merits and Demerits of Mulching.
5. Cropping Systems – Tropical and subtropical Horticultural Systems – Monocropping – Multiple cropping – Inter cropping, Factors determining choice of inter crop – Mixed cropping – Ratoon cropping – Multi storey or Multi tier cropping; Temperate Horticultural Systems – Medium High density planting, Optimum high density planting viz., - Tatura trellis – Pyramid system – Cordon system –Curtain system – Hedge row system, Ultra High Density planting viz., - Meadow orchard – Mechanized system – Intersive system.
6. Plant Interaction – Types of Interactions in cropping systems – Competitive interaction – above ground and below ground – Complimentary Interactions– Annidation in space and time –Allelopathy–Types. Biological efficiency of cropping systems – Crop Equivalent Yield – Land equivalent Ratio – Cropping Intensity Index.
7. Systems of Irrigation – Surface systems – Flooding – Check or bed method –Furrow method – Border method – Basin method – Ring method – Drip (surface)method – Pitcher method – Pipe method – Soil sloping method – Merits and Demerits
8. Sub surface systems – Straight trench method – Cross trench method – Circular trench method – Perforated pipeline method – Trench drip method – Buried drip method – Merits and Demerits – Over Head System – Sprinkler system of irrigation– Merits and Demerits.

9&10. Soil Management in relation to soil organisms – Ploughing and tillage – continuous cultivation – crop rotation – Irrigation – Liming – Gypsum – Fertilizers and manures – Oil cakes – Soil Aggregation – Soil management in relation to Nutrient uptake – Soil physical conditions – Soil Fertility – Soil reaction – Climatic factors – Crop factors – Soil management in relation to water uptake – Soil water – Factors influencing infiltration – Soil properties of orchard and estate – Continuous cultivation – Tillage – Inter cultivation – Soil management on soil environment – Soil environment – Soil temperature and plant growth.

11. Integrated Nutrient Management (INM) – Concept – Need for INM – Components of INM – Soil source – Mineral fertilizer – Organic sources – Biological sources – Merits of INM – Nutrient Management in orchards – Factors affecting fertilizer use – Soil – Crop – Climate – Economic factors – Time of application – Root distribution

and nutrition – Frequency of application – Method of application of fertilizers in orchards – Surface application – Trench application – Punch bar method – Feeding needles – Foliar application – Fertigation – Tree injection.

12. Integrated Pest Management (IPM) Pest Management – definition – objectives, concept - Components of pest management - Cultural methods, Physical methods, Biological methods – merits and demerits.

13&14. Pollination and fruit set problems – Pollination – Self and Cross pollination – Definitions of fruit setting – Fruitfulness – Fertility – Self Fertility – Self sterile – Cross unfruitful – Pollinator – Polliniser – Causes of unfruitfulness – Internal factors – Evolutionary tendencies – Structural peculiarities – Dichogamy – Impotency from abortive flowers – Impotency of pollen – Genetic influences – Sterility or unfruitfulness due to hybridity – Incompatibility – Physiological influences – slow pollen tube growth – premature or delayed pollination – nutritive condition of plant – External factors – Nutrient supply – Pruning and grafting – Locality – Season – Temperature – Light – Pests and diseases .

15. Utilization of resources, constraints in existing systemsland/soil resources, constraints and maintenance for important fruit crops.

16. Crop model and Crop regulations in relation to cropping systems – Crop regulation in pineapple –fig – Aonla – Bahar treatment – Citrus – Guava – Pomegranate – Canopy management in Mango – Apple – Plum – Pear – Peach – Guava. Rejuvenation of old orchards- Top working - Frame working.

PRACTICALS:

1. Layout of different systems of orchard and estate soil management
2. Study of clean cultivation
3. Study of Inter-cropping systems in orchards
4. Study of cover cropping with suitable examples
5. Study of mixed – cropping with suitable examples
6. Study of filler crops in orchards, characteristics of a filler plant
7. Study of Use of Organic and Inorganic mulches
8. Study of moisture conservation methods

9&10. Use of different weedicides in orchards

11&12. Layout of Basin and ring system of irrigation

13&14. Layout of Drip irrigation system

15. Layout of sprinkler irrigation system
16. Visit to local orchards.

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FRSC 3.1.2 DRYLAND HORTICULTURE 2(1+1)

THEORY:

1. Definition, importance and limitation of dry land horticulture, present status and future scope. Constraints encounter in dry lands.
2. Agro-climatic features in rain shadow areas, scarce water resources, high temperature, soil erosion, run-off losses etc.

3 & 4. Techniques and management of dry land horticulture, watershed development, soil and water conservation methods-terraces, contour bunds, *etc.*

5 & 6. Methods of control and impounding of run-off water-farm ponds, trenches, and macro catch pits, etc., *in-situ* water harvesting methods, micro catchment, different types of tree basins etc.

7. Methods of reducing evapo-transpiration use of shelterbelts, mulches, antitranspirants, growth regulators, etc.

8 & 9. Water use efficiency-need based economic and conjunctive use of water, micro systems of irrigation etc.

10. Selection of plants having drought resistance.

11&12. Special techniques- planting and after care - use of seedling races, root stocks, *in-situ* grafting, deep pitting/planting, canopy management etc.

13. Characters and special adaptation of crops: Ber, aonla, annona.
14. Characters and special adaptation of crops: Jamun, wood apple, bael, pomegranate.
15. Characters and special adaptation of crops: Carissa, date palm, phalsa, fig.
16. Characters and special adaptation of crops: West Indian cherry and tamarind.

PRACTICALS:

1. Study of rainfall patterns.

2& 3. Special techniques-Contour bunding/trenching, micro catchments

4. Study of soil erosion and its control.
5. Study of evapotranspiration
6. Study of different types of mulches and its advantages
7. Study of different techniques of micro irrigation systems.
8. Special techniques of planting and aftercare in dry lands.
9. Visit to local orchards.

10, 11 & 12. Study of morphological and anatomical features of drought tolerant crops- Ber, aonla, almond, jamun, wood, apple, bael, pomegranate.

13, 14 & 15. Study of morphological and anatomical features of drought tolerant crops- Carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

17. Visit to local institutions.

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DEPARTMENT OF VEGETABLE SCIENCE

VGSC-2.2.1 TEMPERATE VEGETABLES, POTATO AND TUBER CROPS 3(2+1)

THEORY:

1. Area, production and productivity of temperate vegetables, potato and other tuber crops in India - economical, industrial nutritional importance of temperate vegetables, potato and tubercrops.
2. Cole crops:Cabbage (*Brassica oleracea* var. *capitata*): Introduction, origin, area and production, nutritional value, distribution and export potential-cultivars-classification based on shape, colour and crop duration, soil and climate requirements
3. Production technology: - Nursery techniques – seed rate and nursery sowing main field preparation – transplanting, spacing, - irrigation – nutrition – Inter cultivation – stage of maturity – method of harvesting and yield – Post harvest handling and storage- Physiological disorders
4. Cauliflower (*Brassica oleracea* var. *botrytis*): Introduction, origin, area and production, nutritional value – Distribution and export potential – cultivars-types and classification – soil and climate- Seed rate and nursery sowing – transplanting, spacing and irrigation- nutrition – Deficiency symptoms of nutrients.
5. Inter cultivation and blanching- stage of maturity, harvesting and yield – post harvest handling and storage- Physiological disorders and their control.
6. Brussels Sprouts (*Brassica oleracea* var. *gemmifera*): Introduction, Origin, area and production, nutritional composition and uses – cultivars – production technology – soil and climate – seed rate and sowing – transplanting, spacing, - Irrigation – nutrient management – inter cultivation – harvesting and yield – Post harvest handling and storage.
7. Sprouting Broccoli (*Brassica oleracea* var. *italica*): Introduction origin, Area and Production, nutritional value- cultivars–production technology–soil and climate- seed rate and sowing. transplanting, spacing and irrigation – nutrition – inter cultivation- harvesting and yield – Post harvest handling and storage.
8. Knol– Khol (*Brassica oleracea* var. *gongylodes*): Introduction, Origin, Area and Production, nutritional value- cultivars – Production technology – soil and climate- seed rate and sowing, transplanting, spacing and irrigation – nutrition – inter cultivation- harvesting and yield – Post harvest handling and storage.
9. Chinese Cabbage (*Brassica rapa* subsp. *pekinensis*): Introduction, origin, area and production, nutritional value- cultivars – Production technology – soil and climate- seed rate and sowing-transplanting, spacing and irrigation – nutrition – inter cultivation- harvesting and yield – Post harvest handling and storage.
10. Bulb Crops: Onion (*Allium cepa*): Introduction, origin, history, area, production and productivity–distribution and export potential–nutritional value– cultivars – soil and climatic requirements.
11. Production technology: Propagation and planting methods–seed rate and sowing-main field preparation–transplanting, spacing,-irrigation-nutrition–deficiency symptoms of nutrients – Inter cultivation – stage of maturity,

harvesting, curing and yield – post harvest handling and storage – physiological disorders.

12. Garlic (*Allium sativum*)& Leek (*Allium porrum*): Introduction, origin, area and production, nutritional value- cultivars – production technology – soil and climate- seed rate and sowing. transplanting, spacing and Irrigation – nutrition – Inter cultivation- harvesting and yield – Post harvest handling and storage.
13. Salad crops: Lettuce (*Lactuca sativa*) & Celery (*Apium graveolens*):
    introduction, origin, importance and nutritional value–cultivars–types of lettuce–production technology–soil and climate – seed rate, sowing/ planting – spacing, irrigation – nutrition – inter cultivation – harvesting and yield – post harvest handling and storage.
14. Root crops: Carrot (*Dacus carota* subsp. *sativus*): Introduction, origin, area, production and productivity -nutritional value – pungency and pigmentation – cultivars- classification of cultivars based on root shape and temperature response to flowering (Asiatic and European) – Production technology – soil and climate – seed rate, sowing and spacing, - irrigation - nutrition – inter culture – harvesting and yield – Post harvest handling and storage. physiological disorders (splitting, forking and cavity spot)
    Radish (*Raphanus sativus*):Introduction, origin, area, production, productivity, nutritional value- pungency and pigmentation– cultivars–Asiatic and European ty0pes–production technology– Soil and climate–seed rate, sowing and spacing, -Irrigation- nutrition– interculture–harvesting and yield– Post harvest handling and storage.
    Beetroot (*Beta vulgaris* subsp. *vulgaris*): Introduction, Origin, Area, Production and productivity-nutritional value–pigmentation–Cultivars–Classification based on root shape- Production technology – soil and climate – seed rate, sowing and spacing, - Irrigation, - nutrition – Inter culture – harvesting and yield – Post harvest handling and storage.
15. Turnip (*Brassica rapa* subsp. *rapa*): Introduction, Origin, Area, production and productivity –nutritional value–pungency and pigmentation–Cultivars–Asiatic and European types – production technology – Soil and climate – seed rate, sowing and spacing, - Irrigation – Nutrition –Production technology- Soil and climate – seed rate, sowing and spacing-Irrigation–Nutrition–Interculture–Harvesting and yield–Post Harvest Handling and Storage.
16. Legumevegetables:Pea(*Pisumsativum*):Introduction,Originandtaxonomy–
    Area,Production and productivity – nutritional value-botany – distinguishing characters – Cultivars classification of cultivars based on seed texture, height of plant of, maturity and use of pods.
17. Production Technology – Soil and climate – seed rate, methods of sowing and spacing, - Irrigation – Nutrition – Inter culture – use of plant growth regulators – maturity indices (tenderness) – Harvesting and yield – Post harvest handling and Storage.
18. Broad bean (*Vicia faba*): Introduction, origin, area, production and productivity – nutritional value – cultivars – production technology – soil and climate – seed rate, sowing and spacing, irrigation – nutrition – inter culture- harvesting and yield – post harvest handling and storage.
19. Leafy vegetables:Palak/Spinach beet/Indian spinach (*Beta vulgaris* var. *bengalensis*): Introduction, origin, nutritional value -botany and cultivars – differentiation with spinach – production technology – soil and climate – seed

rate, sowing and spacing – irrigation – nutrition – inter culture- harvesting, yield and storage.

20. Spinach (*Spinacia oleracea*): Introduction, Origin, nutritional value– botanyCultivars–classification of cultivars based on seed type and leaf type - production Technology–Soil and climate–seed rate, sowing and spacing, Irrigation-Nutrition –Inter culture – Stage of maturity- Harvesting, Yield and storage.
21. Specialty vegetables:
    Rhubarb (*Rheum rhabarbarum*), Asparagus (*Asparagus officinalis*) and Globe artichoke (*Cynara cardunculus* var. *scolymus*): Introduction, Origin, importance and nutritional value – Cultivars – production Technology – Soil and climate- propagation and planting methods – seed rate, sowing and spacing,- Irrigation – Nutrition- Inter culture- Stage of maturity – Harvesting, Yield and storage.
22. Potato (*Solanum tuberosum*):
    Introduction,origin,area,production,productivity,history an distribution–role in indian economy- importance and nutritional value- cultivars- potato zones.
23. Production Technology – Soil and climate – propagation and planting material true potato seed (tps) – seed rate – main field preparation, sowing/planting and spacing – irrigation – nutrition – interculture. harvesting, curing and yield–post harvest handling and storage-physiological disorders- production of certified seed – suggestions to produce healthy seed in indian plains.
24. Tuber crops:
    Sweet potato (*Ipomoea batatus*): Introduction, Origin, area and production-nutritional value – cultivars – soil and climate – propagation and planting- seed rate and spacing,-irrigation–nutrition–Interculture (turning of vines)-harvesting, curing and yield – Post harvest handling and storage.
25. Tapioca/Cassava (*Manihot esculenta*): Introduction, origin, area and Production - nutritional value and toxic principle – Cultivars – production Technology – Soil and climate–Propagation and planting material–seed rate and spacing,-Irrigation–Nutrition – Inter culture – Harvesting, yield and storage.
26. Yams(*Dioscorea* sps.): Introduction, Origin, area and production –nutritional value and uses–alkaloids–types of Yams–Cultivars–Production Technology– Soil and climate – propagation and planting material – seed rate and spacing, Irrigation – Nutrient management – Inter culture (training of vines – Harvesting, Yield and storage.
27. Elephant foot Yam (*Amorphophallus paeoniifolius*): Introduction, Origin, area and production – nutritional value – acridity principle – cultivars – production technology–soil and climate–propagation and planting material – seed rate and spacing, - Irrigation – Nutrition – Inter culture – harvesting, curing, yield and storage.
28. Colocasia/ Taro (*Colocasia esculenta*): Introduction, origin, area and production nutritional value – acridity principle – Cultivars – Production technology – Soil and climate-propagation and planting material–seed rate and spacing,-Irrigation - Nutrition – Inter culture – Harvesting, curing, yield and storage.
29. Arrow root (*Maranta arundinacea*) & Arrow leaf Elephant Ear (*Xanthosoma sagittifolium*): Introduction, Origin and importance – nutritional value – Cultivars – Production Technology – Soil and climate – propagation and planting material- seed rate and spacing, irrigation–nutrition– Interculture– Harvesting, yield and storage.
30. Arrow leaf Elephant Ear (*Xanthosoma sagittifolium*): Introduction, Origin and importance – nutritional value – Cultivars – Production Technology – Soil and

climate – propagation and planting material–seed rate and spacing,irrigation–nutrition–Interculture– Harvesting, yield and storage.

31. Horseradish (*Armoracia rusticana*): Introduction, origin and importance – nutritional value – cultivars – production technology – soil and climate – propagation and planting material–seed rate and spacing,-irrigation– nutrition–interculture– harvesting, yield and storage.
32. Jerusalem artichoke (*Helianthus tuberosus*): Introduction, origin and importance – nutritional value – cultivars – production technology – soil and climate – propagation and planting material–seed rate and spacing,-irrigation–nutrition–interculture– harvesting, yield and storage.

PRACTICALS:

1. Visit to vegetable fields, identification and classification based on different parameters of temperate vegetables, potato and tuber crops
2. Visit to local vegetable nursery, propagation and nursery raising including high –tech nursery production and its management
3. Identification and description of cole crops, leguminous and salad vegetable crop varieties/hybrids
4. Identification and description of bulb and root crop varieties/hybrids
5. Identification and description varieties of potato and other tuber crops including under exploited tuber crop varieties/hybrids
6. Methods of main field preparation, sowing/transplanting/planting
7. Study of special cultural operations followed in production of temperate vegetables, potato and tuber crops
8. Study of irrigation and nutrient management in production of temperate vegetables, potato and tuber crops
9. Study of weed management and use of herbicides in production of temperate vegetables, potato and tuber crops
10. Prevention, identification and correction of nutrient deficiencies and physiological disorders in temperate vegetables, potato and tuber crops
11. Study on insect pest and disease management practices followed in production of temperate vegetables, potato and tuber crops
12. Study on use of plant growth regulators in production of temperate vegetables, potato and tuber crops
13. Study of harvesting indices and harvesting of temperate vegetables, potato and tuber crops
14. Study of post harvest management, storage and marketing of temperate vegetables, potato and tuber crops
15. Working out of cost of cultivation in production of temperate vegetables, potato and tuber crops
16. Project preparation on commercial cultivation of temperate vegetables, potato and tuber crop

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- Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.

VGSC-2.2.2 TROPICAL AND SUB-TROPICAL VEGETABLES 3(2+1)

THEORY:

1. Olericulture–definition-area, production and productivity of tropical and sub-tropical vegetables in India – India's position in the world vegetable production, India's vegetable contribution to Indian economy-leading states in vegetable area, production and productivity – export potential of vegetables.
2. Importance of vegetables: nutritional, source of farm income, aesthetic value, medicinal value, Economic and importance of vegetables.
3. History and Scope of vegetable production in India
4. Organizations involved in vegetable production and development in India and in the world
5. Classification of Vegetable Crops: 1) Botanical 2) Based on Hardiness 3) plant parts used 4) Method of culture 5) Season of cultivation
6. Vegetable Gardening: Types of vegetables gardens – kitchen garden, market garden, truck garden, vegetable forcing, garden for processing, seed production garden and floating garden
7. Special systems of vegetable farming: Protected cultivation, hydroponics, riverbed cultivation and organic farming

8 -11. Tomato (*Solanum lycopersicum*): Introduction, origin, area and production, composition and use, pigmentation, distribution and export potential of Tomato: description of cultivars (Indian/Exotic) determinate, semi-determinate and indeterminate types; cultivars suitable for hills and cultivars suitable for processing - exotic cultivars. Production Technology: soil and climate – method of raising the crop nursery vs direct sowing, seed rate nursery techniques–main field preparation–basal application of nutrients – transplanting, spacing – irrigation – nutrition – fertilizers schedule, major nutrients, minor nutrients, deficiency of nutrients. Inter cultivation – weed control mulching. effect of chemicals & growth substances on various growth and yields parameters, stages of maturity, harvesting and yield–grading (4 Grades-SuperA, Super, Fancy & Commercial) –Post Harvest Handling and Storage. Physiological Disorders: blossom end rot, cracking, cat face, puffiness, sun scald, gold fleck, blotchy ripening, crease stem, internal blackening, lower stem swelling, low temperature injury *etc.*Off-season tomato production; value addition-economics.

12-14. Brinjal (*Solanum melongena*): introduction, origin, area and production, nutritional composition, distribution and export potential of brinjal; flower types based on style length-cultivars. Production technology: soil and climate; cultivation; seed rate, seed treatment and raising of nursery, land preparation, transplanting, spacing, irrigation, manures and fertilizers-inter culture and rationing in brinjal. Effect of growth substances on fruit set, harvest indices –colour, glossy appearance, calyx and stem ends; yield, grading and storage and economics.

15-17. Chilli (*Capsicum annuum*): introduction, origin, area and production, composition and uses of chilli - pigmentation and pungency, distribution and export potential of chilli-taxonomy-cultivars. Production Technology: soil and climate-methods of raising the

crop-nursery vs. direct sowing, seed rate -nursery techniques-main field preparation-spacing- irrigation-nutrition-fertilizers scheduling, bio-fertilizers-intercultivation. Effect of growth substances on flowering, fruit set and fruit maturity: stage of maturity for harvesting – for green chilli and dry chilli, harvesting and yield- drying and storage; value addition &economics.

18. Capsicum (*Capsicum annuum* var. *grossum*): introduction, origin, area and production, composition and uses of bell pepper - pigmentation and pungency, distribution and export potential of chilli-taxonomy-cultivars. Production Technology: soil and climate-methods of raising the crop-nursery vs. direct sowing, seed rate - nursery techniques-main field preparation-spacing- irrigation-nutrition-fertilizers scheduling, bio-fertilizers-intercultivation. Effect of growth substances on flowering, fruit set and fruit maturity: stage of maturity for harvesting –yield &economics.

19 & 20. Okra (*Abelmoscus esculentus*): Introduction, origin, area and production, nutritional composition and uses-distribution and export potential of okra-cultivars and hybrids. Production Technology: Soil & climate; cultivation; land preparation, sowing season, seed rate, spacing, nutrition, irrigation and inter culture. Use of growth substances-stage of harvest, harvesting & yield, storage; economics and value addition.

21-24. Cucurbits: Introduction, area and production, origin and distribution, composition and uses, characteristics of cucurbitaceous family-list of cultivated cucurbits (botanical names & common names) bitter principle-flowering, sex mechanisms sex expression-use of plant growth regulators for sex modification. cultivation details of cucumber, pumpkin and squashes –production technology –soil and climate-cultivars-propagation and planting methods –seed rate, spacing, irrigation, nutrient management – inter culture–weed control, mulching, plant growth regulators – maturity indices – harvesting and yield.

Cultivation details of gourds-production technology–soil and climate, cultivars – propagation and planting methods – seed rate, spacing, irrigation, nutrient management – inter culture – weed control, mulching, plant growth regulators – maturity indices – harvesting and yield.

Cultivation details of melons-production technology–soil and climate cultivars – propagation and planting methods – seed rate, spacing, irrigation, nutrient management – Inter culture – weed control, mulching, plant growth regulators – maturity indices – harvesting and yield – production of seedless water melons.

Cultivation details of ivy gourd (*Coccinia indica*) & Chowchow (*Sechium edule*)-production technology-– soil and climate–cultivars –propagation and planting-methods–spacing, irrigation, nutrient management¬ inter culture- weed control—, mulching, plant growth regulators, maturity indices -harvesting and yield. Seedless watermelon production–River and cultivation of cucurbits–Off-season production of cucurbits.

25. Legume vegetables- French Bean: (*Phaseolus vulgaris*) Introduction, origin, area, nutritive composition classification: according to habit (pole, semi pole and bush types)–production technology: climate and soil-cultivars-season-seed rate, seed

inoculation, spacing, nutrition, irrigation and inter cultivation; maturity standards, harvesting, yield, storage & economics.

26. Lablab (Dolichos) bean (*Lablab purpureus*) :Introduction, origin, area, nutritive value and uses-cultivars (bush and pole types)-differentiate field beans and garden beans – cultivation, climate and soil, seeds and sowing, season, spacing, nutrient requirements, irrigation, intercropping; harvesting, yield.

27. Cluster Bean (*Cyamopsis tetragonolobus*) :Introduction, origin, area, nutritive value and industrial importance of guar gum-cultivars classification according to branching, presence/absence of hair and kind of fruit-cultivation-climate and soil, seed rate sowing, spacing, nutrition, irrigation-stage of harvest based on the purposes, yield and storage and economics.

28. Vegetable cowpea (*Vigna unguiculata*): Introduction, origin, Area, nutritive value cultivars–climate & soil, seed rate, spacing, nutrition, irrigation and interculture-harvesting indices – harvesting & yield.

29. Leafy Vegetables: Importance of leafy vegetables and types of leafy vegetables.

Amaranthus: Introduction, origin, Area, nutritive value–cultivars-soil & climate and preparation, sowing seed rate, spacing, irrigation and nutrition – methods of harvesting andyield.

Basella & Sorrel (Botanical Name): Introduction, origin, area and nutritive value-cultivars (Reddish stem type & commonly grown green types)-soil and climate; propagation seed, stem cuttings, crop duration-seed rate, spacing, nutrition, and irrigation – harvesting and yield.

30. Portulaca (*P. oleracea*), Sorrel (*Rumex acetosa*) & Rosella (*Hibiscus sabdariffa*) : Introduction, origin and nutritive value -cultivars soil &climate-land preparation, sowing, seed rate, spacing, irrigation and nutrition–harvesting and yield.

31 & 32. Perennial Vegetables:

Curry Leaf (*Murraya koenigii*) : Introduction, origin, area and nutritive value - cultivars soil & climate, cultivation - land preparation, nursery raising-sowing/ planting, seed rate, spacing, Irrigation, nutrition –harvesting and yield.

Moringa (*Moringa oleifera*) : Introduction, origin, composition of pods, leaves and uses of moringa -cultivars-soil and climate; propagation and planting methods –seed rate –field preparation-sowing/planting-nutrition, Irrigation and inter culture; pruning for extension of cropping season- harvesting and yield.

PRACTICALS:

1. Visit to vegetable fields, identification and classification based on different parameters of tropical and sub-tropical vegetable crops
2. Visit to local vegetable nursery, propagation and nursery raising including high – tech nursery production and its management
3. Identification and description of varieties/hybrids in solanaceous, malvaceous and leguminous vegetable crops
4. Identification and description of varieties/hybrids in moringa, cucurbitaceous and leafy vegetable crops

5. Methods of main field preparation, sowing/transplanting/planting
6. Study of special cultural operations followed in production of tropical and sub-tropical vegetable crops
7. Study of irrigation and nutrient management in production of tropical and sub-tropical vegetable crops
8. Study of weed management and use of herbicides in production of tropical and sub-tropical vegetable crops
9. Prevention, identification and correction of nutrient deficiencies and physiological disorders in tropical and sub-tropical vegetable crops
10. Study on insect pest and disease management practices followed in production of tropical and sub-tropical vegetable crops
11. Study on use of plant growth regulators in production of tropical and sub-tropical vegetable crops
12. Study of harvesting indices and harvesting of temperate vegetables, potato and tuber crops
13. Seed extraction methods in tropical and sub-tropical vegetable crops
14. Study of post harvest management, storage and marketing of tropical and sub-tropical vegetable crops
15. Working out of cost of cultivation in production of tropical and sub-tropical vegetable crops
16. Project preparation on commercial cultivation of tropical and sub-tropical vegetable crops

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VGSC-3.2.1 SEED PRODUCTION OF VEGETABLES, TUBER AND SPICE CROPS 3(2+1)

THEORY:

1. Introduction and History of seed industry in India.
2. Importance and scope of vegetable seed production in India; goals and objectives of seed technology
3. Classification of vegetable crops based on pollination and reproduction behaviour.
4. Seed-definition, different classes of seed-differences between grain and seed.
5. Role of climatic factors (temp, humidity, light, wind velocity and wind direction) vegetables seed production.
6. Principles of vegetable seed production – Genetic Principles (Maintenance of genetic purity by crop rotation, isolation, rouging, seed certification and grow out tests) – Agronomic Principles (area and land selection, source of seed, seed treatment and better agronomic practices.
7. Seed production of Solanaceous vegetables: Tomato: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
8. Brinjal: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
9. Chilli and Bell pepper: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
10. Seed production of cole crops: Cabbage: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
11. Cauliflower: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
12. Seed production of Root vegetables: Carrot: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
13. Radish: Climate, land requirements, season, planting time, nursery management seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
14. Beetroot: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
15. Seed production of Bulb vegetables: Onion & Garlic: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage

16. Garlic: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
17. Seed production of Cucurbits Melons: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
18. Gourds: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
19. Sweet Potato: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
20. Tapioca: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
21. Seed production of Legumes French bean: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
22. Dolichos bean: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
23. Peas: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
24. Seed production of Okra: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
25. Seed production of Leafy vegetables: Amaranthus: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
26. Palak: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
27. Seed production of Spice vegetables: Coriander and Fenugreek: Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
28. Seed production of Major Spices: (Turmeric and Ginger): Climate, land requirements, season, planting time, nursery management, seed rate, flowering and seed setting, rouging, harvesting and threshing, seed extraction and seed storage
29. Seed germination and purity analysis; Seed treatment and seed upgradation
30. Field and seed certification standards (field and seed)
31. Seed legislation and seed laws
32. PPVFRA and Intellectual Property Rights

PRACTICALS:

1. Study of seed structure, color, size, shape and texture of vegetable crops
2. Field inspection and roguing in vegetable seed production plots
3. Methods of seed production and seed certification in cole crops
4. Methods of seed production and seed certification in root crops
5. Methods of seed production and seed certification in bulb crops
6. Methods of seed production and seed certification in solanaceous vegetable crops
7. Methods of seed production and seed certification in cucurbitaceous vegetable crops
8. Methods of seed production and seed certification in leguminous vegetable crops
9. Methods of seed production and seed certification in leafy vegetables and exotic vegetable crops
10. Method and certification of true potato seed production
11. Methods of seed production and seed certification in ginger and turmeric crops
12. Study of harvesting and seed extraction techniques in vegetable, tuber and spice crops
13. Study of seed processing and storage of vegetable, tuber and spice crops
14. Study of seed sampling, germination and purity analysis in vegetable, tuber and spice crops
15. Study of seed vigour, viability and moisture estimation tests in vegetable, tuber and spice crops
16. Visit to commercial seed production and processing unit

REFERENCES:

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DEPARTMENT OF FLORICULTURE

FCLA-1.3.1 PRINCIPLES OF LANDSCAPE ARCHITECTURE 2(1+1)

THEORY:

1. Historical Importance of Gardens in India – History of gardening during Aryan Civilizatio (Epic Era) – Budha period – Emperor Ashoka period – Gupta period – Mughal period – British period – Post independence period.
2. Famous gardens of India - Lal bagh (Bangalore) – Brindavan Garden (Mysore) – Government Botanic Gardens (Ootacamud) – Mughal garden (Pinjore) – Chandigarh Rose garden and abroad.
3. Principles of landscape garden (Axis, rhythm, balance, time & light, space, texture, mass effect, focal point, mobility, emphasis, unity and harmony etc.)
4. Elements of landscape (tangible and intangible elements) gardens.
5. Factors effecting landscape design. (intial approach, view human choice, simplicity, to topography etc.)
6. Definitions, formal, informal, free style and wild gardens basic themes of gardens viz. circular, rectangular and diagonal themes.
7. Important features of English, Japanese, and Mughal gardens.
8. Important features of French, Persian, Italian, Hindu, and Buddhist gardens.
9. Steps involved in preparation of garden design.
10. Use of Auto CAD and Archi CAD in designing gardens.
11. Bio aesthetic planning - definition - objectives - planning and designing of home garden.
12. Planning and designing of gardens in colonies - county side - urban landscapes, planning and planting of avenues.
13. Planning and designing of Institutional gardens – educational (Schools) - railway stations and line - factories, bus Stands - air ports - corporate Buildings,.
14. Planning and designing of gardens at Dams, Hydro electric stations, river banks and play Grounds
15. Planning and designing of gardens for places of religious importance (temples) churches,mosques, tombs etc.)
16. Xeriscaping – definition – Importance - principles and practices – Lay out and Design.

PRACTICALS:

1. Study of garden tools and equipments.
2. Study of graphic language, drawing equipments, symbols and notations in landscape design.
3. Study and designing of formal, informal and free style gardens.
4. Study and designing of gardens based on different themes.
5. Designing gardens using Auto CAD / Archi CAD
6. Study of designing gardens for home and traffic islands.
7. Study of designing gardens for schools and colleges.
8. Study of designing gardens for public buildings, corporate buildings / malls.
9. Study of designing gardens for factories, railway stations and airports.

10. Study of designing gardens for play grounds, temples andchurches.
11. Study of designing and planting of avenues for state and National highways.
12. Study of designing and establishment of Japanese garden.
13. Study of designing and establishment of English garden.
14. Study of designing and establishment of Mughal garden.
15. Visit to near by nurseries of ornamental plants.
16. Visit to public, institutional and botanical gardens

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FCLA - 2.3.1 ORNAMENTAL HORTICULTURE 2(1+1)

THEORY:

1 Definition of Ornamental Horticulture – Importance of Ornamental Horticulture (gardening) – History of gardening – During Aryan Civilization (Epic Era) – Budha Period – Emperor Ashoka period – Gupta period – Mughal Period – British Period – Post Independence Period.

2. Scope and importance of floriculture industry in India – Present Status of floriculture in India – Area and Production of floricultural Products in India – International Scenario – Major exporters and importers in the world – Industrial importance - Cut flowers – Ornamental plants – Flowers seeds – Floral extracts – dry flowers and plants – other floricultural related services.
3. Annuals - biennials – perennials – Grasses – bulbous ornamentals – definition – introduction – classification with suitable examples – Planting – Manuring – Propagation – after care – Maintenance.
4. Climbers – Definition – creepers – Utility (aesthetic values) – Classification with suitable examples – Sunny situation – Partial shade – shade loving climbers – Showy flowering climbers – Climbers with scented flowers – Climbers with attractive foliage – Climbers for pots – Annual climbers – Climbers for hedge making – Soil – Digging of pits – Planting of climbers – After care – Manuring – Maintenance.
5. Ornamental and shady Trees – Definition – Classification based on purpose with suitable examples – Specimen trees – Shady trees – Flowering trees – Avenue or road side trees – Screening trees – Fragrant flowering trees – Pollution controlling trees - Methods of planting – Time of planting – Manuring – Care and Maintenance – Planting Schemes for avenue planting – One kind of flowering tree on both sides – two kinds of flowering trees blooming at one time on both sides of road – Two kinds of flowering trees blooming at different time on both sides of road – shady trees only on both sides of road.
6. Indoor plants – definition – Classification with examples – Propagation – Manuring – Irrigation – After care and its maintenance.
7. Palms – Cycads - Definition – Introduction – Utility (aesthetic values) – Classification with examples – Feather leaved Palm – Fan leaved Palm – Propagation – Pot culture – Potting – Re-potting - Potting media – Manuring – Aftercare.
8. Ferns – Introduction – Utility (aesthetic values) – Propagation – Spore – Division of Clumps – Suckers – bulbils – Site of growing – Soil media – Pot culture – repotting – Irrigation – Indoor culture – Important Examples. Selaginellas – Introduction – Propagation – Cultural hints – Important Examples.
9. Cacti – Introduction – Characteristics of Cactaceae – Classification with Examples – Site of growing – Natural habitat – Domestication (Housing of cacti) – Propagation – Seeds – Offsets – Grafting – Soil – Climate – Containers – Time and method of planting – Potting – Re-potting – Irrigation – Staking – Succulents – Characterstics – differences between cacti and succulents – climate – soil – propagation – seeds – cuttings – watering – re – potting – summer protection.
10. Garden components or features –Garden walls – Retaining wall – Fences and Gates – Steps – Hedges and Edges – Flower bed – Borders – Carpet Bedding Garden Drives (Gravel and Asphalt) and Paths (Gravel, Brick, Grass, Stone, Crazy pavings) – Arches

and Pergolas – Screens – Bridges – Outdoor garden rooms (Gazebos, garden pavilions, band stand, bower and thatched huts) – Patio and decks.

11. Garden adornments – Importance - Garden Seats – Ornamental tubs, urns and Vases – Bird baths – Sun dials – Floral Clocks – Japanese Lanterns – Ornamental Stones – Fountains – statues – Towers – Wells – Plants Containers – Plant Strands.
12. Rock Garden – Types of rock Garden – Selection of site – Construction of the Rockery – Planting – Management of the Rockery – Plants for rock garden – Examples of Cacti and succulents, ferns, shrubs, herbaceous plants, bulbs, flowering annuals – Shade garden – Sunken garden – design –lay out – Maintenance.
13. Roof garden – Terrace garden - Need for roof garden – Limitations – Types of roof garden (Private or cooperative) – Planning – Suitability of the roof – Drainage and water proofing – Making of flower beds, pots and containers – Gardening – Concept – Soil Media – Vertical garden – Bottle garden – Terrariums – Design and its maintenance – suitable plants with examples – Pebble garden – Pools – Bog garden – Children garden – Avenue planting – layout of design and its maintenance.
14. Lawn – Selection of Grass – Bermuda grass – Korean grass – Poa grass – Fescue grass – Kentucky blue grass - Grasses for shady areas – Site Selection – Soil – Preparation of soil – drainage – digging – manuring and grading – Methods of planting – Sowing of Seeds – Dibbling – Turfing – turf plastering – Bricking – Planting on Polythene – Maintenance of lawn – Mowing – Rolling – Sweeping – Scraping – Raking – Weeding – Irrigation – Top dressing with compost and fertilizers – Diseases and other problems – Fairy ring – Pale Yellow Lawns.
15. Selection of flowers and foliage – Line flowers – Form flowers – Mass flowers – Filler flower – Materials required – Design rules – Types of floral arrangement – Circular – Triangular – Radiating – Crescent – Horizontal Hogarthian curve – Conditioning – Reconditioning of flowers - Japanese floral arrangement – Ikebana – Moribana – Nageire – Jiyu-bana-Zen'eika – Zen'ei-bana-Morimono – Materials required – General rules – for Moribana and Nageire styles of arrangement – Basic styles of Moribana and Nageire – Basic upright and Basic slanting arrangements.
16. Bonsai – Definition – Criteria for selecting plants – Examples – Classification of Bonsai – Upright (formal and informal) – Winding – Oblique – Gnarled – Semi-cascade-cascade – Clasped to stone – Containers (pots) and Media – Potting and Re-potting – Training – Pruning and Pinching (Shoot, leaf and root) – Watering – manuring – Defoliation – Mame Bonsai.

PRACTICALS:

1. Identification and description of annuals and biennials.
2. Identification and description of Herbaceous perennials
3. Identification and description of climbers and shrubs
4. Identification and description of trees and indoor plants.
5. Identification and description of Ferns and Selaginellas
6. Identification and description of palms and Cycads
7. Identification and description of Cacti and Succulent
8. Study of Planning and design Landscape garde
9. Features of Landscape garden.

10. Study of Roof garden and water garden.
11. Establishment of Lawn and its maintenance.
12. Layout of design and maintenance of Rock garden.
13. Study of Terrarium and Vertical gardening.
14. Floral Ornaments and flower arrangements.
15. Study of Bonsai training and techniques.
16. Visit to Floriculture units and nurseries.

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FCLA - 3.3.1 COMMERCIAL FLORICULTURE 3(2+1)

THEORY:

1. Commercial Floriculture definition - Scope and importance of commercial floriculture in India - Present status - Future prospects and strategies needed for improvement - Area, production and exports.
2. Rose: Introduction, origin and distribution, Economic importance, classification, species and varieties - climate and soil requirements - propagation – Rootstocks, Stock scion compatability, land preparation, planting.
3. Manures and fertilizers, cultural operations (Training and pruning, disbudding and mulching) use of growth regulators, physiological disorders, harvesting, post harvest management, yield and rose economic products.
4. Marigold: Introduction, origin and distribution, Economic importance, species and varieties, F1 Hybrids, climate and soil requirements, propagation, land preparation, planting.
5. Manures and fertilizers, cultural operations, (pinching and disbudding) use of growth regulators, harvesting, post harvest management and yield.
6. Chrysanthemum: Introduction, origin and distribution, Economic importance, classification, species and varieties, climate and soil requirements, propagation, land preparation, planting
7. Manures and fertilizers, cultural operations, (pinching and disbudding) use of growth regulators, harvesting, post harvest management and yield.
8. Orchids: Introduction, origin and distribution, Economic importance, classification, species and varieties, climate and growing medial requirements, propagation, orchidarium construction, planting
9. Manures and fertilizers, cultural operations, physiological disorders, use of growth regulators, harvesting, post harvest management and yield.
10. Carnation: Introduction, origin and distribution, Economic importance, classification, species and varieties, climate and soil requirements, propagation, land preparation, planting.
11. Manures and fertilizers, cultural operations, (pinching, disbudding and netting) use of growth regulators, physiological disorders, harvesting, post harvest management and yield.
12. Gladiolus: Introduction, origin and distribution, Economic importance, classification of varieties, species and varieties, climate and soil requirements, propagation, land preparation, planting.
13. Manures and fertilizers, cultural operations, use of growth regulators, physiological disorders, harvesting, post harvest management and yield.
14. Jasmine: Introduction, origin and distribution, Economic importance, classification, species and varieties, climate and soil requirements, land preparation propagation, planting
15. Manures and fertilizers, cultural operations, (Training and pruning, defoliation) use of growth regulators, harvesting, post harvest management and yield and Essential oils.
16. Crossandra**:** Introduction, origin and distribution, Economic importance,

Species and varieties, climate and soil requirements, land preparation propagation, planting.

17. Manures and fertilizers, cultural operations, use of growth regulators, harvesting, post harvest management and yield.
18. Anthurium**:** Introduction, origin and distribution, Economic importance, classification, species and varieties, climate and soil requirements, growing media, propagation, planting
19. Fertigation, cultural operations, de-suckering, defoliation, use of growth regulators, physiological disorders, harvesting, grades, post harvest management and yield.
20. Dahlia: Introduction, origin and distribution, Economic importance, classification, species and varieties, climate and soil requirements, land preparation propagation, planting
21. Manures and fertilizers, cultural operations, (pinching and disbudding) use of growth regulators, harvesting, post harvest management and yield.
22. Tuberose: Introduction, origin and distribution, Economic importance, classification, species and varieties, climate and soil requirements, land preparation, propagation, planting
23. Manures and fertilizers, cultural operations, use of growth regulators, harvesting, post harvest management and yield, Essential oils.
24. Bird of paradise: Introduction, origin and distribution, Economic importance, classification, species and varieties, climate and soil requirements, propagation, land preparation, planting
25. Manures and fertilizers, cultural operations, use of growth regulators, harvesting, post harvest management and yield.
26. China aster: Introduction, origin and distribution, classification, Economic importance, species and varieties, climate and soil requirements, propagation, land preparation, planting
27. Manures and fertilizers, cultural operations, (pinching and disbudding) use of growth regulators, harvesting, post harvest management and yield.
28. Gerbera: Introduction, origin and distribution, Economic importance, classification, species and varieties, climate and soil requirements, propagation, land preparation, planting
29. Manures and fertilizers, cultural operations, defoliation, soil loosening, shading, use of growth regulators, physiological disorders, harvesting, post harvest management and yield.
30. Growing of flowers under protected environments such as glass house, plastic house etc. Rose, Orchids, Anthurium, Carnation, Gerbera and cut flower type Chrysanthemums.
31. Post harvest technology of cut flowers – causes for deterioration of cut flower quality – Food depletion – Bacterial and fungal infections – Maturation and ageing – Wilting – Bruising – Temperature – Ethylene – Water – Factors affecting cut flower longevity – Handling – Harvest stage – Grading and Bunching – Packaging – Pre – cooling – Storage – Floral preservatives viz., (Pulsing solution – Bud opening solution – Vase solution – Conditioning) – Sanitation.

32. Dehydration technique for drying of flowers – Importance – Pot – pourri – Dehydration methods – Air drying – Embedding and drying – viz., room drying – Sun drying – hot air oven – vacuum drying – microwave drying – Embedding individual flower – embedding individual flower with stem – Embedding branch with flowers – Press drying (simple method, herbarium method).

PRACTICALS:

1. Propagation methods in chrysanthemum
2. Preparation of nursery bed for sowing of flower seeds.
3. Identification and description of important flower crops and their varieties.
4. Identification and description of important fillers and foliage plants.
5. Propagation methods in roses.
6. Propagation methods, Training and pruning, defoliation in Jasmine.
7. Training and pruning in roses.
8. Special horticultural practices in cut flowers.
9. Harvesting stages of cut flowers and loose flowers.
10. Physiological disorders of cut flowers.
11. Study on drip irrigation and misting of flower crops.
12. Study on the influence of plant growth regulators on important flower crops
13. Use of floral preservatives and other compounds for prolonging vase life of Cut flowers.
14. Methods of Drying / Dehydration techniques in flower crops
15. Value added/Economic products of flower crops.
16. Visit to polyhouses of flower crops..

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DEPARTMENT OF PLANTATION, SPICES, MEDICINAL AND AROMATICS

PSMA 2.4.1 SPICES AND CONDIMENTS 3(2+1)

1. Introduction, history of spices, definition of spices and condiments, important spice crops of India (List of the crops with Common name, Botanical name and family), Importance, role of spices in human nutrition, industry, exports and imports of spices in improving the national economy.
2. Classification of Spices – Different classifications based on economic importance, cultivation methods, family, longevity of spice plants, type of the spice, origin and flavour, plant part used, active principle. Institutes working on spices and condiments.
3. Role of organizations for improvement of spices and condiments like IISR, ICAR, DASD, Spices Board.
4. Black Pepper – History, scope and Importance area and production, uses, export potential and its role in increasing the national economy, role of pepper export promotion council, botany, varieties, soil and climate, selection of site, systems of cultivation, propagation, seed and vegetative methods, cuttings, Rapid Multiplication Method.
5. Black Pepper - Establishment of pepper garden, planting of standards, planting of the vines, shade and shade regulation, training and pruning of pepper vines. nutritional management, irrigation, weed control.
6. Black Pepper -Harvesting, post harvest technology, types of pepper, preparation of black pepper and white pepper, package and storage, value added products like dehydrated green pepper, freeze dried green pepper, essential oil, pepper oleo resin, pepper hulls.
7. Cardamom – History, scope and importance, area and production, uses, export potential, Botany, varieties, types of cardamom like, Malabar, Mysore and Vazukka, soil and climate, selection of site and land preparation, propagation, seed (Primary and Secondary nurseries advantages and disadvantages) and vegetative Methods.
8. Cardamom - Systems of cropping like inter cropping and mixed cropping, planting, shade and shade regulation, nutrient management, irrigation, weeding, intercultural operations like thrashing, mulching earthing up.
9. Cardamom - Harvesting indices, yield, post harvest technology – various methods of drying and curing like 1. Sun drying and 2. Solar drying 3.Mud platform curing 4. Flue cuing, bleaching of the cardamom, packaging and storage, value added products.
10. Ginger– Introduction, scope and importance, area and production, uses export potential, botany, varieties, soil and climate, propagation, preservation of seed rhizome, selection of land and land preparation.
11. Ginger - Planting season, seed rate, spacing, methods of planting – bed system and ridge and furrow system, seasons of planting, mulching, systems of cultivation like rotation and mixed cropping, irrigation, nutrient management, weeding and intercultural operations, shading.
12. Ginger - Harvesting indices, harvesting and yield, post harvest technology –dried ginger – bleached and un-bleached ginger, preserved ginger, storage, value added products like soft ginger beverage, ginger candy, murabba, pickles, ginger wine.

13. Turmeric – Introduction, history, scope and importance, area and production, uses, export potential, botany, varieties, soil and climate.
14. Turmeric – Propagation, preservation of seed rhizome, selection of land and land preparation, methods of cultivation like bed system, ridge and furrow system, planting, season of planting, seed rate, spacing, mulching, irrigation, nutrient management, weeding and intercultural operations, shade provision, cropping systems like inter cropping, rotation
15. Turmeric – Harvesting indices, harvesting and yield, post harvest technology - different methods of cooking – 1. Traditional method 2. Improved method, Drying, Polishing and colouring ,packing and storage, value added products like Turmeric powder, oil and oleoresin
16. Clove – Introduction, history, scope, importance, area and production, uses, export potential, botany, varieties, soil and climate, propagation by seed – raising of the nursery, planting, weeding, staking, manuring, interculture, irrigation, pruning.
17. Clove –Harvesting, curing and processing, preparation of clove to the market, grading, packing and storage, value added products like clove bud oil, clove stem oil, clove leaf oil, clove root oil, oil of mother clove.
18. Nutmeg– History, importance, area, production, uses, botany, varieties, export value, propagation - nursery techniques, soil and climate, planting, cropping system, manuring, weeding, intercultural operations, constraints like sex determination and improvement in Nutmeg Cultivation.
19. Nutmeg–Harvesting, post harvest technology, grading and packing, value added products like oil of mace, Nutmeg volatile oil, Nutmeg butter
20. Cinnamon – Importance, area and production, uses, propagation, botany, varieties, export potential, pruning, soil and climate, planting, weeding, manuring.
21. Cinnamon –Harvesting and yield, post harvest technology – cutting and peeling, preparation of Quills, drying, grading – Quills, Quillings, Featherings, Chips, packaging and storage, value added products.
22. All Spice – Introduction, area and production, uses, soil and climate, propagation, weeding, manuring, harvesting, post harvest technology and value added products like Berry oil, Leaf oil, Oleo resin.
23. Curry leaf- Introduction, area and production, uses, export value, soil and climate, propagation, weeding, manuring, harvesting, post harvest technology and value added products like volatile oil and dehydrated leaves.
24. Coriander– History, importance, area and production, uses, botany, varieties, soil and climate, sowing, season, seed rate, spacing, irrigation, weeding, intercultural operations, harvesting, post harvest management like cleaning and drying, value added products ,whole seed, ground form, volatile oil, oleoresin, coriander dal etc.
25. Fenugreek – History, importance, area and production, uses, botany, varieties, soil and climate, sowing, season, seed rate, spacing, irrigation, weeding, intercultural operations, harvesting, post harvest management like cleaning and drying, value added products.
26. Fennel – History, importance, area and production, uses, botany, varieties, soil and climate, sowing, season, seed rate, spacing, irrigation, weeding, intercultural operations, harvesting, post harvest management like Cleaning and drying, value added products.

27. Cumin – History, importance, area and production, uses, botany, varieties, soil and climate, sowing, season, seed rate, spacing, irrigation, weeding, intercultural operations, harvesting, post harvest management like Cleaning and drying, value added products
28. Vanilla – History, importance, area and production, export value, uses, botany, varieties, constraints of production, propagation by cuttings, soil and climate, land preparation, staking, planting, manuring, flowering and pollination, hand pollination.
29. Vanilla – Harvesting, curing and processing and types of vanilla like Mexican vanilla, Bourbon vanilla, Indonesian vanilla, value added products, grading, packing, storage.
30. Nigella and Betelvine - Area and production, uses, botany, varieties, soil and climate, propagation, spacing, irrigation, weeding, intercultural operations, harvesting, post harvest management, value added products.
31. Saffron, Dill, Celery - Common name, botanical name, family, importance, uses, botany.
32. Thyme, Bishop's weed and Rose Mary- Common name, botanical name, family, importance, uses, botany.

PRACTICALS:

1. Identification of Spices and Condiments. Preparation and Submission of minimum of 30 specimen of Spices and Condiments.
2. Seed Treatment, Sowing layout and Planting Method of Spices and Condiments
3. Raising of crops of spices and condiments.
4. Propagation methods of spices and condiments. (Black pepper, Cardamom, Turmeric, Ginger)
5. Propagation methods of spices and condiments. (Nutmeg, Clove, Curry leaf, Vanilla, Coriander, Fennel, Fenugreek, Cumin)
6. Identification of varieties of spices and condiments. (Black pepper, Cardamom, Turmeric, Ginger)
7. Identification of varieties of spices and condiments. (Nutmeg, Clove, Curry leaf, Vanilla, Coriander, Fennel, Fenugreek, Cumin)
8. Intercultural operations in spices and condiments. (Black pepper, Cardamom, Turmeric, Ginger)
9. Intercultural operations in spices and condiments. (Nutmeg, Clove, Curry leaf, Vanilla, Coriander, Fennel, Fenugreek, Cumin
10. Economics of cultivation of Spices and condiments (Turmeric, Ginger, Coriander, Fenugreek, Curry leaf and Ajowan)
11. Postharvest technology of Spices and Condiments. (Black pepper, Cardamom, Turmeric, Ginger)
12. Postharvest technology of Spices and Condiments. (Nutmeg, Clove, Curry leaf, Vanilla, Coriander, Fennel, Fenugreek, Cumin)
13. Methods of extraction of essential oils and oleoresins in Spices and Condiments.
14. Preparation of value added products of Spices and condiments
15. Visit to Commercial Plantations and Processing Units.
16. Visit to Commercial Plantations and Processing Units.

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PSMA 2.4.2 PLANTATION CROPS 3(2+1)

THEORY:

1. Introduction, History of plantation crops, definition, importance and role of plantation crops in human nutrition, industry, exports and imports in improving the National Economy.
2. Institutions working for development of plantation crops.
3. Coconut – History and introduction, area and production, uses, export and import potential, value added products and industrial importance. Botany, varieties and hybrids, soil and climate.
4. Coconut – Propagation (seeds), planting material and its production, selection of seedlings. Planting – Spacing, digging of pits, care of young palms, manuring of young palms, gap filling, nutrient management, Irrigation and moisture conservation.
5. Coconut – Inter cultivation, cropping systems like cover cropping, inter cropping, mixed cropping, pruning like leaf pruning, soil management practices.
6. Coconut – Physiological disorders, harvesting, post harvest handling and processing like copra, oil, packaging and marketing.
7. Arecanut – History, importance, area and production, uses, botany, varieties, soil and climate, propagation by seed, raising of the nursery, preparation of land, planting, irrigation, manuring.
8. Arecanut – Interculture, leaf pruning, cropping methods like inter cropping, harvesting, processing methods like 1. Dehusking and cutting, 2. Boiling and curing, grading, value addition, marketing.
9. Oil palm – History, importance, area and production, uses , botany, varieties, soil and climate,propagation, irrigation management.
10. Oil palm – Manuring, weeding, cropping method like cover cropping, pruning like leaf pruning, harvesting, grading.
11. Oil plam – Processing of oil palm, packaging, marketing.
12. Cacao – History, importance, uses, area and production, botany, varieties, soil and climate, propagation like seed and vegetative methods like cutting and budding.
13. Cacao – Establishment of cacao plantation, planting, pruning done for shaping and maintenance, weeding, irrigation, manuring.
14. Cacao – Harvesting – indices, method of harvesting, yield, processing, procedure involved in processing, value added products like cocoa butter, cocoa nibs, cocoa powder, chocolates, packaging and marketing.
15. Cashew nut – History, importance, area and production, uses, botany, cashew apple, cashew nut shell liquid, varieties from Bapatla, Maharshtra, TamilNadu, Kerala, Karnataka, soil and climate, propagation like seed and vegetative methods like epicotyl grafting and soft wood grafting.
16. Cashew nut – Site selection and land preparation, planting, irrigation, mauring, weeding and inter cultivation, cropping system like inter cropping.
17. Cashew nut – Training and pruning, harvesting – indices, yield.
18. Cashew nut – Processing – procedure involved, value added products, cashew apple, cashew testa, cashew nut shell liquid, grading, packing, marketing.
19. Palmyrah palm – History, importance, area and production, uses, botany, varieties, soil and climate, propagation.
20. Palmyrah palm – Planting, irrigation, manuring, weeding, inter culture, harvesting, post harvest management, value added products.

21. Tea – History, importance, area and production, uses, export potential, botany, varieties, differences between Assam tea, China tea and Natural hybrids, soil and climate, propagation by seed and cuttings, raising of the nursery, land preparation, planting, style of planting, season, spacing.
22. Tea – Pruning – first year pruning, second year pruning, third year pruning, types of pruning, rejuvenation pruning, shade and shade regulation, manuring, mulching and liming, irrigation, weeding.
23. Tea – Harvesting, plucking of the leaves, yield, post harvest technology – manufacturing of tea, grading, packing and marketing.
24. Coffee – Introduction, importance, area and production, botany, varieties – differences between Arabica and Robusta coffee, propagation – seeds and cuttings, soil and climate (Arabica and Robusta).
25. Coffee – Establishment of coffee plantation – selection of site and preparation of land, planting, provision of shade, training like single stem system, multiple stem system and pruning like centering, desuckering, handling and nipping, pruning, manuring, irrigation, cropping systems like inter cropping, soil management like stirring, mulching, weed control, liming.
26. Coffee – Harvesting – types of picking like fly picking, main picking, stripping and gleaning, processing – wet processing, dry processing, value added products – coffee husk, coffee pulp, grading, packing and marketing.
27. Rubber – Introduction, importance, area and production, botany, varieties, propagation by seed and budding, soil and climate.
28. Rubber – Planting – stake planting, stump planting, basket planting, training and pruning, manuring – immatured trees, matured trees, irrigation, weeding, cropping system – cover cropping, mixed cropping.
29. Rubber – Tapping – systems of tapping – puncture tapping, slaughter tapping, rain guarding, marketing forms of rubber, processing – ribbed smoke sheet, crepe rubber, value added products.
30. Datepalm – Importance and uses, area and production, botany, varieties, soil and climate, selection of land and preparation.
31. Datepalm – Layout and establishment, Irrigation, manuring, intercultural operation, cropping methods, harvesting, grading, marketing
32. Indian/Wild Datepalm- Importance, uses, botany ,Production technology.

PRACTICALS:

1. Description and identification of coconut and arecanut varieties.
2. Description and identification of varieties of cashew, cocoa and coffee.
3. Selection of mother palm, seed nuts and planting of seed nuts in the nursery of coconut and arecanut.
4. Propagation in cocoa, Rubber and Cashewnut
5. Propagation in Tea, Coffee and Oilpalm
6. Layout and planting of coconut and arecanut.
7. Training and pruning in Tea ,Coffee and Cashew nut.
8. Harvesting and processing of Tea and coffee.
9. Harvesting and processing of Rubber.
10. Harvesting and processing of cocoa and cashewnut.
11. Harvesting and processing of Oil palm and Palmyrah palm.
12. Working out of economics and project preparation for coconut, arecanut.
13. Working out of economics and project preparation for oilplam, cashewnut.

14. Working out of economics and project preparation for Tea and Coffee.
15. Visit to Commercial plantations and Processing units.
16. Visit to Commercial plantations and Processing units.

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PSMA 3.4.1 MEDICINAL AND AROMATIC CROPS 3(2+1)

THEORY:

1. History, scope Importance, area, production, present status (Export & Import), future prospects, Opportunities and Constraints in the cultivation of Medicinal Crops, Institutions on Medicinal and Aromatic crops.
2. ALOE : Introduction, Importance, uses, origin, distribution, description of plant, species and varieties, soil, climate, land preparation, cultivation – propagation, crop duration, spacing & planting, manures and fertilizers, irrigation, weeding, inter cultivation, pests and diseases, harvesting (time and method of harvesting) and yield, chemical evaluation.
3. ASWAGANDHA**:** Introduction, Importance, uses, origin, distribution, description of plant, varieties, soil, climate, Cultivation – propagation, manures and fertilizers, inter cultivation (thinning and weeding), pests and diseases, Harvesting, crop duration, method of harvesting and drying, grading, yield. Chemical constituents, extraction procedures.
4. BELLADONA **:**Introduction, importance, uses, origin and distribution, description of plant, varieties, soil, climate, land preparation, Cultivation – propagation, sowing (broadcasting) / transplanting, spacing, manures and fertilizers, irrigation, inter cultivation, pests and diseases, harvesting, drying and yield, Chemical constituents.
5. CINCHONA **:**Introduction, importance, uses, origin and distribution, Botany, species and varieties, soil and climate, land preparation, Cultivation – propagation, spacing & planting, manures and fertilizers, weeding, inter crops (cover cropping), staking, pests and diseases, harvesting – method of harvesting and yield of bark, isolation of active principle.
6. COLEUS **:**Introduction, importance, uses, origin and distribution, description of plant, varieties, soil & climate, Cultivation – propagation, spacing & planting, manures and fertilizers, irrigation, weeding, pests and diseases, harvesting and yield of tubers.
7. DIOSCOREA **:**Introduction, importance, uses, origin and distribution, Botany, species and varieties, soil & climatic requirements of various species, Cultivation- Propagation, season, field preparation, spacing,
8. DIOSCOREA**: planting**, staking, manures and fertilizers, irrigation, interculture & inter cropping, plant protection, duration of the crop, harvesting, yield & marketing. Chemical constituents.
9. ISABGOL **:**Introduction, importance, uses, origin and distribution, area and production, description of plant, varieties, soil & climate, Cultivation - Propagation, manures and fertilizers, irrigation, interculture, pests and diseases, harvesting & processing, yield, Chemical constituents.
10. KALMEGH **:**Introduction, importance, uses, origin and distribution, botany, varieties, soil & climate, Cultivation - Propagation, land preparation, manures and fertilizers, irrigation, weeding, pests and diseases, harvesting & yield, Chemical constituents.
11. LONG PEPPER **:**Introduction, importance, uses, origin and distribution, description of the plant, wild species and varieties, soil & climate, land preparation, Cultivation – Propagation, Spacing & planting, manures and fertilizers, irrigation, interculture, mulching, pests and diseases, harvesting, drying & yield, grading, chemical constituents.

12. POPPY **:**Introduction, importance, uses, origin and distribution, area and production, description of the plant, varieties, soil & climate, Cultivation – Propagation, spacing, manures and fertilizers, irrigation, interculture and weeding, flowering and fruit-set, pests and diseases, lancing and latex collection, processing, harvesting of seeds, yield of crude opium and seed, Chemical constituents.
13. PERIWINKLE **:**Introduction, importance, uses, origin and distribution, description of the plant, types and varieties, soil & climate, Cultivation – Propagation, Direct sowing / Nursery raising and Transplanting, spacing & planting, manures and fertilizers, irrigation, weed control, pests and diseases, harvesting & yield, identification and estimation of chemical constituents.
14. RAUVOLFIA: Introduction, importance, uses, origin and distribution, description of the plant, varieties, soil & climate, Cultivation – Propagation, spacing & planting, manures and fertilizers, irrigation, weeding and interculture, intercropping, pests and diseases, harvesting, processing & root yield, chemical constituents.
15. SENNA **:**Introduction, importance, uses, origin and distribution, description of the plant, varieties, soil & climate, land preparation, Cultivation – Propagation, sowing, manures and fertilizers, crop rotation and intercropping, irrigation, weeding and interculture, pests and diseases, harvesting, processing, storage, yield, estimation of sennosides.
16. STEROID-BEARING SOLANUM **:**Introduction, importance, uses, origin and distribution, description of the plant, varieties, soil & climate, land preparation, Cultivation – Propagation, spacing & planting, manures and fertilizers, irrigation, interculture, pests and diseases, harvesting and processing of berries, yield, chemical constituents.
17. SWEET FLAG **:**Introduction, importance, uses, origin and distribution, description of the plant, species / varieties, soil & climate, planting season, land preparation, Cultivation – Propagation, spacing & planting, manures and fertilizers, irrigation, weeding, pests and diseases, harvesting, yield, chemical constituents.
18. Ammi majus,Glorylily, Liquorice, Guggal **:** Introduction, Importance, uses, description of plant, varieties. Chemical constituents.
19. History, Importance, area, production, present status (Export & Import), future prospects, Opportunities and Constraints in the cultivation of Aromatic Crops.
20. Extraction or production methods for essential oil crops – Distillation - Water distillation, Water& steam distillation, Steam distillation,Distillation process ,Enfleurage or Cold fat extraction, Maceration or Hot fat extraction, Solvent extraction, Expression, Super critical fluid extraction (SCFE), storage techniques of essential oils.
21. AMBRETTE **:**Introduction, importance, uses, origin and distribution, description of the plant, varieties, soil & climate, land preparation, Cultivation – Seed propagation, sowing, manures and fertilizers, irrigation, pests and diseases, harvesting & yield, chemical constituents.
22. BURSERA **:**Introduction, importance, Origin and distribution, description of the plant, Varieties, soil & climate, Cultivation – propagation, planting, pruning and training, manures and fertilizers, irrigation, Intercropping, pests and diseases, non-insect pests and external Damages, harvesting, Extraction of Essential oil & yield, chemical constituents.
23. CITRONELLA **:**Introduction, importance, uses, origin and distribution, area and production, description of the plant, varieties, soil & climate, land preparation,

Cultivation – Propagation, spacing & planting, manures and fertilizers, irrigation, interculture, pests and diseases, harvesting & distillation, yield of herb and oil, chemical constituents.

24. LEMON GRASS **:**Introduction, importance, uses, origin and distribution, area and production, description of the plant, varieties, soil & climate, land preparation, Cultivation – Propagation, spacing & planting, manures and fertilizers, irrigation, interculture, pests and diseases, harvesting & distillation, yield of herb and oil, chemical constituents.
25. PALMAROSA **:**Introduction, importance, uses, origin and distribution, description of the plant, soil & climate, Cultivation – Propagation, nursery & transplanting, spacing, manures and fertilizers, irrigation, interculture, growth regulator application, pests and diseases, harvesting, distillation, yield and oil content, chemical constituents.
26. GERANIUM **:**Introduction, importance, uses, origin and distribution, description of the plant, varieties, soil & climate, Cultivation – Propagation, spacing & planting and after-care, manures and fertilizers, pests and diseases, harvesting & yield, distillation of oil, chemical constituents.
27. KHUS GRASS **:**Introduction, importance, uses, origin and distribution, distribution, description of the plant, types and varieties, soil & climate, land preparation, Cultivation – Propagation, spacing & planting, manures and fertilizers, irrigation and interculture, pests and diseases, harvesting & yield, oil content and yield, Chemical constituents.
28. MINT **:**Introduction, importance, uses, origin and distribution, description of the species of mint, varieties, chemical composition and uses, seasons, soil & climate, land preparation, Cultivation – Propagation, spacing & planting, manures and fertilizers, irrigation, interculture and weed control, crop rotation, pests and diseases, harvesting & yield, distillation of oil, storage of oil
29. OCIMUM SPECIES (SACRED BASIL, FRENCH BASIL) CLOVE BASIL and CAMPHOR BASIL **:** Introduction, importance, uses, origin and distribution, description of the plant, types and varieties, soil & climate, season, land preparation, cultivation – Propagation, planting, spacing, manures and fertilizers, irrigation, weeding, interculture, pests and diseases, harvesting & yield, distillation of oil, chemical constituents.
30. OCIMUM SPECIES (CLOVE BASIL and CAMPHOR BASIL) **:**Introduction, importance, uses, origin and distribution, description of the plant, types and varieties, soil & climate, season, land preparation, cultivation – Propagation, planting, spacing, manures and fertilizers, irrigation, weeding, interculture, pests and diseases, harvesting & yield, distillation of oil, chemical constituents.
31. PATCHOULI, DAVANA, LAVENDER, LEMONG SCENTED GUM**:** Introduction, importance, uses, description of the plant, varieties, chemical constituents.
32. PYRETHRUM **:**Introduction, importance, uses, origin and distribution, description of the plant, types and varieties, soil & climate, season, land preparation, cultivation – Propagation, planting, manures and fertilizers, interculture, irrigation, pests and diseases, harvesting, drying, yield of flowers and pyrethrin content, extraction and storage of oleoresin

PRACTICALS:

1. Collection of locally available medicinal plants, morphological description of the plants and preparation of herbarium.
2. Collection of locally available medicinal plants, morphological description of the plants and preparation of herbarium.
3. Collection of locally available aromatic plants, morphological description of the plants and preparation of herbarium
4. Collection of locally available aromatic plants, morphological description of the plants and preparation of herbarium
5. Propagation and nursery techniques for important aromatic crops.
6. Propagation and nursery techniques for important aromatic crops.
7. Propagation and nursery techniques for important medicinal plants
8. Propagation and nursery techniques for important medicinal plants
9. Harvesting techniques for important medicinal plants.
10. Drying, curing and primary processing for important medicinal plants.
11. Harvesting techniques for important aromatic crops.
12. Extraction of aromatic oil through steam distillation process at field level – parts of a steam distillation unit, principle of distillation process.
13. Extraction of aromatic oil through hydro distillation process at laboratory level
14. Visit to Ayurvedic pharmacy
15. Visit to commercial perfumery industry
16. Visit to CIMAP/MAPRS, Rajendranagar,SKLTSHU/Commercial farms

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DEPARTMENT OF POST HARVEST TECHNOLOGY

PHTH – 2.5.1 FUNDAMENTALS OF FOOD TECHNOLOGY 3(2+1)

THEORY:

1,2 &3.	Packaging situations in World, India; Need of packaging; Package requirements, package functions; **:**Classification of packages
4,5 &6.	Paper, corrugated and paper board boxes: as package material, its types, advantages, disadvantages. Different types of packaging materials, their key properties and applications
7,8 &9.	Glass, as package material, its types, advantages, disadvantages. Different types of packaging materials, their key properties and applications
10,11 &12	Metal (Aluminium/ tin/ SS) as package material, its types, advantages, disadvantages. Different types of packaging materials, their key properties and applications, Metal cans, manufacture of two piece and three piece cans
13,14,15 &16.	Plastic as package material, its types, advantages, disadvantages. Different types of Packaging materials, their key properties and applications, Plastic packaging, different types of polymers used in food packaging and their barrier properties.
17&18.	Nutritional labelling on packages
19.	CAS and MAP
20.	Shrink and cling packaging
21.	Vacuum and gas packaging;
22.	Active packaging, Smart packaging
23&24.	Packaging requirement for raw and processed foods, and their selection of packaging materials, Factors affecting the choice of packaging materials
25.	Disposal and recycle of packaging waste
26.	Printing and labelling
27.	Lamination Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials;
28.	Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.),
29.	Plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.),
30.	Aluminium foil (thickness, pin holes, etc.),
31.	Glass containers (visual defects, colour, dimensions, impact strength, etc.),

32. Metal containers (pressure test, product compatibility, etc.)

PRACTICALS:

1&2. Classification of various packages based on material and rigidity
3. Identification different types of packaging material
4. Determination of tensile/ compressive strength of given material/ package
5. Study of to perform different destructive and non destructive tests for glass containers
6. Vacuum packaging of horticultural produces
7. Measurement of water absorption of paper and paper board
8. Determination of tearing strength of paper board
9. Study of measurement of thickness of packaging materials
10. Determination of bursting strength of packaging material
11. Determination of water-vapour transmission rate
12. Shrink wrapping of various horticultural produce
13. Testing of chemical resistance of packaging materials
14. Study of Pre packaging of fruits and vegetables
15. Study of different types mental containers used in packaging
16. Visit to packaging industries

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PHTH- 3.5.1 POSTHARVEST MANAGEMENT OF HORTICULTURAL CROPS 3(2+1)

THEORY:

1.	Importance of Postharvest Technology in horticultural crops.
2,3&4.	Maturity indices, harvesting, handling, grading of fruits, vegetables, cut flowers, plantation crops, spices, medicinal and aromatic plants.
5.	Pre-harvest factors affecting quality,
6.	factors responsible for deterioration of horticultural produce,
7.	physiological and bio-chemical changes,
8.	hardening and delaying ripening process
9.	Postharvest treatments of horticultural crops.
10.	Quality parameters and specifications.
11&12.	Structure of fruits, vegetables and cut flowers related to physiological changes after harvest.
13.	Methods of storage for local market and export.
14,15&16.	Pre-harvest treatment and pre-cooling, pre-storage treatments.
17.	Different systems of storage,
18&19.	Packaging methods and types of packages, recent advances in packaging.
20,21&22.	Types of containers and cushioning materials, vacuum packaging, cold storage, poly shrink packaging, grape guard packing treatments. Modes of transport.
23	Chilling and freezing: Application of refrigeration in different perishable horticulture produce.
24	Thermophilic, Mesophilic & Psychrophilic micro-organisms,
25,26&27	Chilling requirements of different fruits and vegetables, slow and fast freezing, Equipment for chilling and freezing (mechanical & cryogenic), Effect on horticultural produce during chilling and freezing,
28	Cold storage and cold storage design, refrigerated vehicle and cold chain system
29,30&31	Dryers for fruits and vegetables, Osmo-dehydration;
32.	Supply chain of fresh fruits and vegetables.

PRACTICALS:

1&2. Practice in judging the maturity of various horticultural produce

3. Study of harvesting indices in vegetables, flowers, spices, medicinal and aromatic crops

4. Harvesting & primary processing of flowers

5. Determination of physiological loss in weight

6. Post harvest treatment of horticultural crops-physical and chemical methods

7&8. Grading of fruits and vegetables

9. Grading of cut flowers

10. Packaging studies in Fruits and vegetables by using different packaging material

11. Methods of storage

12. Identification of storage pests and diseases
13. Study of Post harvest disorders of horticultural crops
14. Visit to markets,
15. Visit to packing houses
16. Visit to cold storage units

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PHTH – 3.5.2 PROCESSING OF HORTICULTURAL CROPS 3(1+2)

THEORY:

1. Importance and scope of fruit and vegetable preservation industry in India, food pipe line, losses in post-harvest operations, unit operations in food processing. Principles and guidelines for the location of processing units.

2&3. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages. Jam, jelly and marmalade.

4,5&6. Preservation by sugar and chemicals, candies, crystallized fruits, preserves, chemical preservatives, preservation with salt and vinegar, pickling, chutneys and sauces, tomato and mushrooms, freezing preservation.

7. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Flowcharts for preparation of different finished products, Important parameters and equipment used for different unit operations,

8. Post harvest management and equipment for spices and flowers.

9&10. Quality control in Fruit and vegetable processing industry. Govt. policy on import and export of processed fruits. Food laws. FSSAI specifications.

11. Principles and methods of preservation; Primary processing and pack house handling of fruits and vegetables.

12. Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables; Minimal processing of fruits and vegetables.

13,14 &15. Blanching operations and equipment; heat- Pasteurization; Canning: Definition, processing steps, and equipment, cans and containers, quality assurance and defects in canned products; bottling.

16. Commercial processing technology of selected fruits and vegetables for production of various value added processed products.

PRACTICALS:

1. Identification of equipment used for preservation of fruits and vegetables
2. Determination of total soluble solids (TSS)
3. Determination of titratable acidity
4. Determination of ph in food products
5. Determination of moisture content and total solids
6. Estimation of reducing sugars in fruits and vegetables
7. Determination of ascorbic acid (vitamin c)
8. Estimation of total phenol content
9. Estimation of total carotenoids and β-carotene
10. Canning and bottling of fruits
11. Canning and bottling of vegetables
12. Preparation of jam

13. Preparation of fruit jelly
14. Preparation of marmalade
15. Preparation of RTS (ready to serve)
16. Preparation of cordial
17. Preparation of squash
18. Preparation of syrup
19. Preparation of candies and preserves
20. Study of preparation of pickles
21. Preparation of tomato pickle
22. Preparation of chutneys
23. Preparation of sweet and sour chutneys
24. Preparation of ketchup and sauce
25. Drying and dehydration of fruits and vegetables
26. Determination of rehydration ratio in fruits and vegetables
27. Study of freezing of fruits
28. Study of freezing of vegetables
29. Processing of plantation crops
30. Detection of adulteration and examination of horticultural produce
31. Cut out analysis of canned products
32. Visit to processing units

REFERENCES

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DEPARTMENT OF ENTOMOLOGY

ENTO – 1.6.1 FUNDAMENTALS OF ENTOMOLOGY 3(2+1)

THEORY:

1. Introduction to phylum arthropoda and classification of phylum Arthropoda upto classes, *viz.*, Symphyla, Crustacea, Arachnida, Chilopoda, Diplopoda and Insecta. Relationship of class Insecta with other classes of Arthropoda: Position of phylum Arthropoda in Animal Kingdom. Characters of phylum Arthropoda.
2. Importance of class Insecta - Division of class Insecta into subclasses – Apterygota and Pterygota – orders under Apterygota. Division of Pterygota into exopterygota and endopterygota and orders under each with important examples
3. Insect dominance in Animal Kingdom.
4. History of entomology in India, Importance of entomology in different fields-Citations about Insects and their economic importance in ancient Sanskrit writings, scientific study of insects in modern India. Record of Indian Insects by Linnaeus, Fabricius, Cramer, Koenigi and Anderson. Publication of Fauna of British India. Maxwell Lefroy, T.B. Fletcher,T.V. Ramakrishna Ayyar, H.S.Pruthi, S.Pradhan and their contributions. Establishment of Indian Lac Research Institute, Directorate o Plant Protection Quarantine and Storage, Division of Entomology at IARI, Institute of Biological Control, Initiation of Veterinary and Medical Entomology, Apiculture, Sericulture and lac culture.
5. Definition, division and scope of entomology.
6. Body segmentation, head, thorax, abdomen and genetalia-Principle divisions of body segments, Tagmosis, Primary and secondary segmentation, Sclerites and sutures of head, divisions of thorax and abdomen its structure and appendages. Epimorphic and anamorphic development in insects.
7. Comparative account of external morphology-types of mouth parts with examples
8. Types of antennae and legs with examples
9. Wings: Venation, cross veins, margins and angles, areas of wing.
10. Types of insect wings and types of wing coupling mechanism.
11. Cuticle: Structure, function &process of moulting
12. Digestive system in insects: structure – foregut, midgut and hindgut, peritrophic membrane, filter chamber. Digestive enzymes and process of digestion and absorption.
13. Circulatory system: Blood, Circulatory organs involved in circulation of blood – dorsal blood vessel, dorsal and ventral diaphragms, sinuses, accessory pulsatory organs.
14. Process of circulation in insects.
15. Sensory andglandular system.
16. Respiratory system: Organs of respiration – spiracles, tracheae and tracheoles, air sacs, mechanism of respiration. Classification of respiratory system on the basis of functional spiracles. Respiration in aquatic insects. Process of respiration in insects.
17. Excretory system in insects: Organs involved (Malphigian tubules, integument, tracheal system *etc*.) accessory organs of excretion (nephrocytes, fat bodies, labial glands *etc*.) process of excretion and osmoregulation, functions of Malphigian tubules, cryptonephry
18. Nervous system: Different types of neurons, nerve impulse conduction
19. Structure of insect nervous system: Central nervous system, visceral nervous system and Peripheral nervous system.

20. Female reproductive system – structure, physiology of ova production, different types of ovarioles.
21. Male reproductive system – structure, physiology of sperm production, different types of reproduction in insects.
22. Embryonic and Postembryonic development-eclosion.
23. Metamorphosis. Types of metamorphosis in insects (Ametabola, Hemimetabola, Paurometabola, Holometabola, Hypermetabola). Types of egg, larvae and pupa.
24. Brief history of classification, Nomenclature definition, objectives, Guidelines for the Binomial nomenclature as indicated by ICZN, Law of priority.
25. Taxonomy – Definition of Taxonomy, importance, history and development – Binomial nomenclature. Definitions of species, genus, family and order.
26. Study of order and family characters of Orthoptera (Acrididae), Dictyoptera (Blattidae, Mantidae)
27. Isoptera (Termitidae), Thysanoptera (Thripidae), Hemiptera (Pentatomidae, Tingidae, Miridae), Homoptera (Cicadellidae, Aphididae, Coccidae, Aleurodidae, Pseudococcidae).
28. Lepidoptera (Noctuidae, Sphingidae, Pyralidae, Hesperidae, Papilionidae, Arctidae, Gelechidae, Lymantridae, Cochlididae).
29. Coleoptera (Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Scarabaeidae, Apionidae)
30. Hymenoptera (Tenthridinidae, Trichogrammatidae, Formicidae, Apidae, Ichneumonidae, Braconidae, Chalcididae).
31. Diptera (Cecidomyiidae, Trypetidae, Tachinidae, Agromyzidae)
32. Plant mites – morphological features, important families with examples

PRACTICALS:

1. Insect collection and preservation. Identification of important insects.
2. General body organization of insects. Study on morphology of grasshopper or cockroach.
3. Preparation of permanent mounts of mouth parts and study of their types.
4. Preparation of permanent mounts of antennae and study of their types.
5. Preparation of permanent mounts of legs and study of their types.
6. Preparation of permanent mounts of wings and study on types of wings and wing coupling apparatus.
7. Dissection of grasshopper and caterpillar for study of internal morphology.
8. Observations on metamorphosis of egg, larvae and pupae.
9. Dissection of male and female reproductive system in insects (grasshopper).
10. Study of characteristics of orders Orthoptera and Dictyoptera and their families
11. Study of characteristics of orders Isoptera, Thysanoptera and their families
12. Study of characteristics of order Hemiptera and its families
13. Study of characteristics of order Lepidoptera and its families
14. Study of characteristics of order Coleoptera and its families,
15. Study of characteristics of order Hymenoptera and its families
16. Study of characteristics of order Diptera and its families

Note: Submission of well-maintained, labeled insect specimens of various orders during final practical examination is mandatory.

REFERENCEs:

- General and Applied Entomology (1976) – K.K.Nayar, T.N.Ananthakrishnan and B.Vasanthraj David. Tata McGraw Hill Publishing Comp., New Delhi
- Imm's general text book of entomology Vol.II (1997) Richard O.W. and Davies R.G. .Chapman & hall, London.
- The insects structure and function (1982), R.F.Chapman. Edward Arnold (Publishers) Ltd., London
- Insect physiology and anatomy,(1981). N.C. Pant and S.Ghai, ICAR, New Delhi.
- Principles of Insect Morphology (2001). Snodgrass R.E. CBS Publishers and
- Distributors, New Delhi

ENTO 2.6.1 NEMATODE PESTS OF HORTICULTURE CROPS AND THEIR MANAGEMENT 2(1+1)

THEORY:

1. History and development of nematology - definition, economic importance (*Pratylenchus, Radopholus, Hirschmaniella, Meloidogyne, Heterodera, Globodera, Rotylenchulus, Tylenchulus, Ditylenchus, Anguina, Aphelenchoides, Tylenchorhynchus, Helicotylenchus, Hoplolaimus, Scutellonema, Paratylenchus* etc.).
2. General characters of plant parasitic nematodes
3. Nematode morphology

4&5. Nematode anatomy *i.e.* various systems: Digestive, excretory, nervous system and sense organs etc.

6. Reproductive system and developmental biology of nematodes (Nematode embryogenesis)
7. Nematode taxonomy (Principles and concepts of taxonomy. Rules of nomenclature)

8&9. Classification of soil and plant parasitic nematodes and their relationship with other related phyla. Detailed classification of plant parasitic nematodes up to generic level with emphasis on genera of economic importance and their description

10. Nematode biology, symptomatology, distribution and control of important plant parasitic nematodes of fruits
11. Nematode biology, symptomatology, distribution and control of important plant parasitic nematodes of – (tropical, sub-tropical and temperate) vegetables
12. Nematode biology, symptomatology, distribution and control of important plant parasitic nematodes of tuber crops
13. Nematode biology, symptomatology, distribution and control of important plant parasitic nematodes of ornamental crops
14. Nematode biology, symptomatology, distribution and control of important plant parasitic nematodes of spice and plantation crops.
15. Role of nematodes in plant disease complex.
16. Integrated nematode management - Physical, Cultural, biological, chemical and legislative, nematicides**.**

PRACTICALS:

1. Study of general characters of plant parasitic nematodes.

2&3. Classification of nematodes and their description.

4. Methods of sampling and extraction of nematodes from soil.
5. Extraction of nematodes from plant parts. Killing and fixing of nematodes
6. Preparation of temporary and permanent nematode mounts.
7. Symptoms of damage by nematodes in fruit crops.
8. Symptoms of damage by nematodes in vegetable crops.
9. Symptoms of damage by nematodes in tuber crops
10. Symptoms of damage by nematodes in ornamental crops
11. Symptoms of damage by nematodes in spices and plantation crops.

12. Field visit to collect and preserve 20 plant species/parts damaged by plant parasitic nematodes.
13. Recording of data and other nematode damage indice.
14. Management of plant parasitic nematodes
15. Role of nematodes in disease complex.
16. Nematicides and their use in Nematode management

REFERENCE:

- A text book of plant nematology, Upadhyay. K. D and K. Dwivedi, 1997, A man publishing house, Meerut .
- Elements of economic entomology, Vasanth Raju David. B, 2001 Popular book Depot, Chennai.
- Plant Parasitic Nematodes of India, Gopal Swaroop and Das Gupta, 1986 Problems and Progress, ICAR, New Delhi.
- Pest Management in Horticultural Crops, Raja Goud CH and Manasa K 2020, Kalyani Publishers, New Delhi.

ENTO – 2.6.2 INTEGRATED PEST MANAGEMENT 1(1+0)

THEORY:

1. IPM- Definition, Introduction - Importance –concept & principles of IPM - phases of crop protection - evolution of IPM - Causes of pest outbreak - scope and limitations of IPM.
2. Agro ecosystem – concept of Injury levels - characteristics of Agro ecosystem – understanding of Agro ecosystem, planning Agro ecosystem, cost –benefit/benefit – risk, tolerance of pest damage (EIL, ETL, GEP and DB), leaving pest residue, timing of application and public understanding and acceptance
3. Categories of pests, pest surveillance and pest forecasting
4. Components of IPM
5. Cultural control- normal cultural practices which incidentally control the pests and agronomic practices recommended specifically against the pests with examples
6. Physical control- use of inert carriers against stored product insects - steam sterilization – solarization - solar radiation - light traps - flame throwers etc.;
7. Mechanical control- - different mechanical methods of pest control with examples.
8. Host-plant resistance- principles of host plant resistance – ecological resistance – phenological asynchrony, induced resistance and escape – genetic resistance – mono, oligo and polygenic resistance – 33-40 4 major gene resistance (vertical/specific/qualitative) and minor gene resistance (horizontal/nonspecific/quantitative) – host-plant selection process- host habitat finding, host finding, host recognition, host acceptance, host suitability- Mechanisms of Genetic resistance- nonpreference(antixenosis), antibiosis and tolerance – transgenic plants.
9. Legislative control (plant quarantine)- - importance of quarantine - examples of exotic pests - different legislative measures enforced in different countries including India.
10. Biological control – parasitoids, predators, pathogens (bacteria, fungi, viruses and entomo pathogenic nematodes)
11. Chemical control - importance and ideal properties of insecticide - classification of insecticides based on origin, mode of entry, mode of action and toxicity with examples- toxicity evaluation of insecticides - acute or chronic toxicities, oral and dermal toxicities - LC50 (Lethal Concentration), LD50 (Lethal Dose), ED50 (Effective Dose), LT50 ((Lethal time), KD50 (Knockdown Dose) and KT50 (Knock Down Time) – bioassay methods
12. Formulations of insecticides - dusts, granules, wettable powders, water dispersible granules, solutions, emulsifiable concentrates, suspension concentrates, concentrated insecticide liquids, fumigants, aerosols, baits and mixtures of active ingredients.
13. Recent methods of pest control, repellents, antifeedants, hormones, attractants, gamma radiation, pheromones, genetic control, chemosterilants, insect growth regulators (chitin synthesis inhibitors, juvenile hormone, anti-juvenile hormone)
14. Insecticides Act 1968-Important provisions.
15. Application techniques of spray fluids-- hazards and limitations.
16. Symptoms of poisoning, first aid and antidotes.

REFERENCES:

- Dhaliwal GS and Ramesh Arora 2001. Integrated pest management: Concepts and approaches, Kalyani Publishers Ludhiana

- Gautam,R.D 2008 Biological Pest Suppression. Westville publishing House New Delhi
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- Nair KK , Anantha Krishnan TN and BV David 1976. General and applied entomology, Tata Mc Graw Hill publishing co. Ltd, New Delhi
- Larry P Pedigo 1991. Entomology and pest management, Prentice Hall of India Private Ltd., New Delhi
- Upadhyaya K.P and Kusum Dwivedi.1997. A Text Book of Plant Nematology Aman Publishing House, Meerut
- Venyugopala Rao,N., Umamaheswari,T., Rajendraprasad,P.Naidu,V.G and Savithri,P.2004 . Integrated Insect Pest Management. Agrobios (India) Limited,Jodhpur
- Yazdani,S.S and Agarwal,M.L.1979. Elements of Insect Ecology. Narosa Publishing House,New Delhi

ENTO – 2.6.3 INSECT PESTS OF FRUIT, PLANTATION, MEDICINAL AND AROMATIC CROPS 3(2+1)

THEORY:

1. General – economic classification of insects – Types of insect damages
2. Bio-ecology and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops; pest surveillance.
3. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits, plantation, medicinal and aromatic crops.
4. TROPICAL FRUITS
   Mango: Hoppers, flower webber, Fruit fly, Mango nut weevil, stem borer, leaf/ shoot webber, leaf flea weevil, gall midges, leaf caterpillar, red tree ant, mealy bug, red banded caterpillar
5. Guava: Tea mosquito bug, fruit fly, fruit borer, mealy bug, scale, bark eating caterpillar, Sapota: Leaf webber, bud borer, fruit fly
6. Cashew: Cashew shoot and root borer, shoot and blossom webber, tea mosquito bug, thrips, leaf miner, fruit borer
7. Ber: Ber fruit fly, fruit borer, Banana: Rhizome weevil, pseudostem borer, aphid
8. Papaya: Mealy bug, spiraling whitefly, Pomegranate: Butterfly, fruit sucking moth
9. Wood apple: Castor shoot and fruit borer, Custard apple: Mealy bug, Tamarind: Fruit borer
10. SUBTROPICAL FRUITS
    Grapevine: Flea beetle, thrips, stem girdler, mealy bug, two spotted spider mite
11. Citrus: Fruit sucking moth, butterfly, leaf miner, psylla, white fly, black fly, mangu mite Litchi: Fruit borer, leaf miner, rust mite
12. TEMPERATE FRUITS
    Apple: Sanjose scale, wooly aphid, cottony cushion scale, codling moth, tent caterpillar, gypsy moth, European red mite
13. Peach: Leaf curl, aphid, borer, Plum: Weevil, Apricot: Chalcid

14. & 15. PLANTATION CROPS
    Coconut and oil palm: Black headed caterpillar, rhinoceros beetle, red palm weevil, Eriphyid mite, coconut scale
16. Arecanut: Scales, Mites, thrips, nymphalid butterfly Rubber: Bark caterpillar, scales
17. Tea: Tea mosquito bug, thrips, mite complex (red spider mite, yellow mite, pink mite, purple mite, scarlet mite).
18. Coffee: Green scales, white borer, red borer, shot hole borer, berry borer
    Cocoa: Tea mosquito bug, chaffer beetles.
19. MEDICINAL AND AROMATIC CROPS
    Cinchona: Root grub, slugs Neem: Root grub, slug caterpillar, mirid bug, mealy bug, tea mosquito bug Crotolaria: Sun hemp hairy caterpillar
20. Cinnamon: Leaf eating caterpillar, Jumping bug Camphor: Leaf roller, mealy bug, scales. Mint: Leaf roller, hairy caterpillars, termites, pyralid moth
21. Datura: Spotted borer, thrips Opium: Cut worm, capsule borer, weevil
    Bellodonna: Cut worm, potato beetle, flea beetle

22. Dioscorea: Aphids, red spider mite Betel vine: black fly, thrips, aphids, yellow mite Senna: green leaf eating caterpillar, pod borer
23. Sarpagandha: cut worm, sphingid caterpillar, epilachna beetle, ash weevil, mealy bug Aswagandha: cut worm, fruit borer, epilachna beetle
24. Coleus: whiteflies, aphids, spider mites, slugs
26. Isabgol: white grub , Pyrethrum: aphids, red spider mite
26. Costus: Mylloceros weevil, hairy caterpillar
Crotalaria: Defoliators, pod sucking bugs, aphids, whiteflies, thrips
27. Datura: whiteflies, weevils, thrips, aphids, scales Aloevera: aphids
28. Lemongrass: grass bag worm, yellow sugarcane aphid Citronella: mealy bugs stem borer, spittle bugs *Solanum khasianum*: leaf eating caterpillar, fruit borer, root eating caterpillar.

29&30.Storage insects – distribution, host range, bio-ecology, injury, integrated management of important insect pests attacking stored fruits, plantation and their processed products.

31&32.Insecticide residue problems in fruit, plantation, medicinal and aromatic crops And their maximum residue limits (MRLs).

PRACTICALS:

1. Sampling techniques for estimation of insect damage.
2. Survey, Surveillance and Forecasting of Pest Incidence
3. Calculation of Insecticide. Doses/ concentration of different insecticide Formulations
4. Mass multiplication of parasites, predators and insect pathogen
5. Typical symptoms of damage caused by various phytophagous insects
6. Identification of insect pests of Mango and their damage symptoms
7. Identification of insect pests of Citrus and their damage symptoms
8. Identification of insect pests of grapevine, pomegranate, guava, custard apple and their damage symptoms
9. Identification of insect pests of Sapota, Ber, Banana and papaya and their damage symptoms
10. Identification of insect pests of Coconut, Arecanut and oilpalm and their damage symptoms
11. Identification of insect pests of Cashew, Cocoa, tea and coffee and their damage symptoms
12. Identification of insect pests of Medicinal crops and their pests of damage Symptoms
13. Identification of insect pests of Aromatic crops and their damage Symptoms
14. Identification of insect pests attacking stored fruits, plantation, medicinal And aromatic crops and their processed products
15. Identification of Bird Pests of Horticultural Importance and their Management
16. Identification of Rodent Pests of Horticultural Importance and their Management

Note: Submission of well-maintained, labeled 25 life cycles of various pests of fruit, plantation, medicinal and aromatic crops during final practical examination is mandatory.

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- Raja Goud CH and Manasa K 2020 Pest of Crops and stored Grains and their Management. Kalyani Publishers, New Delhi.
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- Upadhyaya K.P. and Kusum Dwivedi. 1996. A Text Book of Plant Nematology. Aman Publishing House, Meerut.
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- Vasantharaj David, B and Aanathakrishnan, T.N.. 2006. General and Applied Entomology. Tata McGraw-Hill Publishing House, New Delhi.

ENTO – 3.6.1 INSECT PESTS OF VEGETABLE ORNAMENTALS AND SPICE CROPS 3(2+1)

THEORY:

1. Economic importance of insects in vegetable, ornamental and spice crops -ecology and pest management with reference to these crops.
2. Pest surveillance in important vegetable, ornamental and spice crops.
3. VEGETABLES: Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetables
   Brinjal: shoot and fruit borer, stem borer, epilachna beetle, leaf hoppers, aphids, lace wing bug, mealy bugs, leaf webber
4. Bhendi: Spotted boll worms, cotton jassid, white fly, red cotton bug, dusky cotton bug
5. Tomato: fruit borer, serpentine leaf miner, white fly, brinjal stem borer
6. Cucurbits: fruit flies, pumpkin beetles, aphids, snake guard semilooper, pumpkin leaf caterpillar, coccinia gall fly, serpentine leaf miner
7. Crucifers: Diamond back moth, cabbage head borer, cabbage leaf webber, cabbage semilooper, painted bug, aphids, cabbage butterfly, tobacco caterpillar
8. Carrot and turnip: pea leaf miner, flea beetle, carrot rust fly
   Sugarbeet and beet root: beet leaf miner, web worm
9. Potato: potato tuber moth, black cut worm, bihar hairy caterpillar, epilachna beetle, golden cyst nematode
10. Sweet potato: weevil, vine borer, hopper, tortoise beetle
    Colocasia: psylid bug, citrus butterfly, bark borer
11. Yams: Yam beetles, saw fly, leaf eating caterpillars, scale insects
    Curry leaf: psyllid bug, citrus butterfly, bark borer; Moringa: hairy caterpillar, bud worm, bud midge, leaf caterpillar, scale, pod fly, bark caterpillar
12. Leafy vegetables: Amaranthus: caterpillar, leaf webber, stem weevil
    Palak& Spinach: leaf eating caterpillar, aphids
    Peas: Pea leaf miner, pea stem fly, pod borer; Beans: gram pod borer, flower webber, bean aphid, leaf hopper, whitefly, blister beetle
13. ORNAMENTALS
    Rose: Rose aphids, thrips, red scale, leaf cutter bee, tomato fruit borer, defoliators
14. Chrysanthemum: black aphid, composite thrips, leaf miner, mirid bug, flower webber
15. Crossandra: spike borer,crossandra bug, midge, scale insect
16. Jasmine: Bud worm, gallery worm, blossom midge, eriophyid mite, jasmine thrips, stink bug, leaf roller, red spider mite, tingid bug, whitefly, flower thrips.
17. Marigold: Tomato fruit borer, leaf hopper, hairy caterpillar, tarnished plant bug, red spider mite
18. Pests of cut flowers and indoor plants:
    Anthurium: aphids, whiteflies, thrips; Carnation: aphids, thrips, carnation tortrix moth, carnation fly; China aster: stem borer, bud caterpillar
19. Bird of paradise: scale
    Dahlia: aphid; Orchid: weevil, orchid bulb mite and orchid fly, scale, mealy bugs
    Tulip: bulb aphid; Anthurium: green peach aphid
20. Gerbera: green house whitefly, leaf miner, thrips, bud caterpillar, mites
    Gladiolus: thrips, mirid bug; Tuberose: weevil, bud borer, aphids, bulb mite
21. SPICES
    Pepper: pollu beetle, top shoot borer, berry gall midge, hard scales, soft scale, two tailed mealy bug, whitefly, wild silk moth

22. Cardamom: aphid, thrips, castor capsule borer, early capsule borers, rhizome weevil, shoot fly, hairy caterpillar
23. Chillies: thrips, fruit borers, green peach aphid, fruit bug, cotton whitefly, tobacco caterpillar
24. Coriander and cumin: Mealy plum aphid, coriander aphid, cotton whitefly, tobacco caterpillar, cumin aphid
25. Mint: leaf roller, lace wing bug, potato cut worm, Lucerne caterpillar, semilooper
    Fenugreek: Lucerne caterpillar
26. Onion & Garlic: Onion fly, ear wig, onion thrips, tomato fruit borer, tobacco caterpillar, cut worms
27. Turmeric and Ginger: Rhizome maggots, rhizome scales, castor capsule borer, shoot borer
28. Important storage insect-pests of vegetable, ornamental and spice crops their host range, bio-ecology, injury and integrated management.
29. Pest management in polyhouse grown crops
30. Insect – pests of processed vegetable and spice crops, their host range, bio-ecology, injury and integrated management.
31. Insecticidal residue problems in vegetable, ornamental and spice crops, tolerance limits etc.

PRACTICALS:

1. Identification of insect pests of Brinjal and their damage symptoms
2. Identification of insect pests of Bhendi and Tomato and their damage symptoms
3. Identification of insect pests of Cucurbits and their damage symptoms
4. Identification of insect pests of Crucifers and their damage symptoms
5. Identification of insect pests of Potato, Sweet potato, Sugarbeet and Beetroot and their damage symptoms
6. Identification of insect pests of Moringa, Spinach and Amaranthus and their damage symptoms
7. Identification of insect pests of Peas and Beans and their damage symptoms
8. Identification of insect pests of Rose and Chrysanthemum and their damage symptoms
9. Identification of insect pests of Jasmine and their damage symptoms
10. Identification of insect pests of Crossandra and Marigold and their damage symptoms
11. Identification of insect pests of Cut flowers and their damage symptoms
12. Identification of insect pests of Pepper and Cardamom and their damage symptoms
13. Identification of insect pests of Chillies and their damage symptoms
14. Identification of insect pests of Fenugreek, Coriander and Cumin and their damage symptoms
15. Identification of insect pests of Onion, Garlic, Turmeric and Ginger and their damage symptoms
16. Identification of insect pests of stored and processed vegetables, spices and their damage symptoms

Note: Submission of well-maintained, labeled 25 life cycles of various pests of vegetable, ornamental and spice crops during final practical examination is mandatory.

REFERENCES:

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ENTO – 3.6.2 APICULTURE, SERICULTURE AND LAC CULTURE 2(1+1)

THEORY:

1. APICULTURE : Introduction to beneficial insects, Importance and History of apiculture
2. Species of honey bees, Rock bee, Littlebee, Indian bee, European bee, Italian bee and Dammar bee, lifecycle and caste determination.
3. Bee colony maintenance, bee colony activities, starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention, colony management in different seasons.
4. Equipment for apiary, types of bee hivesand their description.
5. Bee pasturage. Honey extraction, honey composition, value and other byproducts.
6. Pests and Diseases of Honey bees
7. SERICULTURE:Importance, History and development in India.
8. Silkworms kinds and their hosts, systematic position, distribution, lifecycles in brief, Silk glands
9. Moriculture-Mulberry varieties, package of practices. Pests and diseases and their management.
   Mulberry silkworm-morphological features, races, rearing house and equipments, disinfection and hygiene.
10. Grainage acid treatment, packing and transportation of eggs, Incubation, black boxing, hatching of eggs.
11. Silkworm rearing young age /chawki rearing and old age rearing of silkworms Feeding, spacing, environmental conditions and sanitation. Cocoon characters colour, shape, hardinessand shell ratio. Defective cocoons and stifling of cocoons.
12. Pests and Diseases of Silkworms
13. Uses of silk and by-products. Economics of silk production.
14. LAC CULTURE**:** Lac growing areas in India, Lac insects, biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac-insects.
15. Lac extraction – production of shellac – other byproducts – uses of lac.

PRACTICALS:

1. Study of important species of honey bees
2. Seasonal management and colony maintenance of bees.
3. Study of different bee hivesand apiculture equipments.
4. Handling of bee hives, honey extraction and bottling.
5. Study of pests and diseases of honeybees.
6. Establishment of mulberry garden. Preparation of mulberry cuttings, planting methods under irrigated and rainfed conditions.
7. Maintenance of mulberry garden-pruning, fertilization, irrigation and leaf harvest.
8. Mulberry pests and diseases and their management and nutritional disorders.
9. Study of different kinds of silkworms
10. Mulberry silkworm morphology, silk glands.
11. Sericulture equipments for silkworm rearing. Mulberry silkworm rearing room requirements.
12. Rearing of silkworms-chalky rearing.
13. Rearing of silkworms late age silkworm rearing and study of mountages.

14. Study of silkworm pests, diseasesand their management.
15. Lac insects-biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping.
16. Lac extraction, Kinds of lac andEnemies of lac insects.

REFERENCES:

- Ganga, G and Sulochana Chetty,J. (1997). An introduction to Sericulture (2nd Edn.). Oxford & IBH publishing Co. Pvt. Ltd. New Delhi.
- Krishnaswamy, S. (Ed). 1978 Sericulture Manual - Silkworm Rearing. FAO Agrl. Services bulletin, Rome.
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- Jolly, M.S 1987 "Appropriate sericulture techniques" International centre for training and Research in Tropical Sericulture , Mysore, 209 p

DEPARTMENT OF PLANT PATHOLOGY

PATH-1.7.1 FUNDAMENTALS OF PLANT PATHOLOGY 3(2+1)

THEORY:

1,2&3. Introduction to the Science of Phytopathology
A) Definition and objectives of Plant Pathology
B) Scope and Historical background
C) Definitions of different kinds of Plant Pathogens *viz.*, Fungi, Bacteria, Virus, Viroids, Fastidious Vascular Bacteria (FVB), Phytoplasmas, Spiroplasmas, Algae, Protozoa, Nematodes.

4,5&6. History & Contributions of Plant Pathologists in the World and India

7&8. Socio-economic importance of Plant diseases in terms of losses caused in the history specifying Late blight of Potato, Cereal rust, Coffee rust, Brown spot of Rice, Sigatoka leaf spot of Banana, Powdery mildew and Downy mildew of Grapes *etc.*,

9,10&11. Classification of Plant diseases, Symptoms, Signs and related terminology

12&13. Parasitic causes of Plant diseases: Classification of Fungi (Ainsworth, 1973) and their Characteristics

14&15. Division – Myxomycota

16&17. Division – Eumycota
Sub- division – Mastigomycotina

18. Sub- division - Zygomycotina

19&20. Sub- division – Ascomycotina

21&22. Sub- division – Basidiomycotina

23&24. Sub- division - Deuteromycotina

25&26. Classification of Phytopathogenic bacteria (Bergey's Manual of Systematic Bacteriology, 1984) and their Characteristics.

27&28. Classification of Plant Viruses their Characteristics and Symptomatology

29&30. Characteristics of Viroids, Fastidious Vascular Bacteria (FVB), Phytoplasmas and Spiroplasmas

31. Characteristics of Algae, Protozoa, Nematodes

32. Non – Parasitic causes of Plant diseases – Environmental factors

PRACTICALS:

1. Familiarity with Plant Pathological Laboratory Equipments
2. Familiarity with Plant Pathological Field Equipments
3. Study of disease symptoms and host parasitic relationship
4. Isolation of Plant pathogens
5. Study of plant pathogenic fungi, Genus *Pythium* and *Phytophthora*
6. Study of plant pathogenic fungi, Genus *Albugo*
7. Study of plant pathogenic fungi, Genus *Peranospora*
8. Study of plant pathogenic fungi, Genus *Rhizopus*
9. Study of plant pathogenic fungi, Genus *Erisiphe*
10. Study of plant pathogenic fungi, Genus *Puccinia*

11. Study of plant pathogenic fungi, Genus *Rhizoctonia*
12. Study of plant pathogenic fungi, Genus *Fusarium*
13. Study of plant pathogenic fungi, Genus *Colletotrichum*
14. Study of plant pathogenic fungi, Genus *Alternaria* and *Cercospora*
15. Bacterial staining
16. Plant virus transmission

REFERENCES:

- Ravichandra, N.V. 2013. Fundamentals of Plant Pathology, PHI, New Delhi.
- Mehrotra, R. S. Ashok Agarwal. Fundamentals of Plant Pathology
- Singh, R.S. Introduction to Principles of Plant Pathology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Alexopoulos, C. J. Mims C. W. & Blackwell M. 1996. Introductory Mycology. Wiley Eastern Ltd, New York.
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- Agrios, G.N. 2006. Plant Pathology. Elseveir Academic Press, New York.

PATH-2.7.1 PRINCIPLES OF PLANT PATHOLOGY 2(1+1)

THEORY:

1&2. History of Plant Pathology, terms and concepts used in Plant Pathology

3&4. Survival of Plant Pathogens – Kinds of inoculums produced by different plant pathogens with examples.
Pattern of Survival
A)Infected host as reservoir of inoculum
B)Saprophytic survival outside the host
C)Survival by means of specialized resting structures
D)Survival in association with Insects, Nematodes and Fungi

5. Dispersal of Plant Pathogens
A)Autonomous dispersal
B)Passive dispersal

6. Phenomenon of Infection
A)Pre – Penetration
B)Penetration
C)Post – Penetration

7. Role of Enzymes in Plant Pathogenesis

8. Role of Toxins in Plant Pathogenesis

9. Role of Growth regulators and polysaccharides in Plant Pathogenesis

10. Defense Mechanisms in Plants

11. Plant disease epidemiology, Remote Sensing

12. Principles and methods of Plant Disease Management
A)Avoidance
B)Exclusion
C)Eradication
D)Protection
E)Immunization
F)Therapy

13&14. Classification of Fungicides, Bactericides and Nematicides based on Chemical nature

15. Integrated Plant Disease Management (IPDM)

16. Biotechnology application in Plant disease management – Transgenic plants

PRACTICALS:

1. Field survey and collection of disease samples
2. Dry and wet preservation of diseased specimens
3. Preservation of Green color in plant specimens

4&5. Diagnosis of disease specimens

6. Isolation of Plant pathogenic fungus
7. Isolation of Bacterial pathogens from infected plant tissue
8. Purification of Fungal cultures
9. Purification of Bacterial cultures

10&11.Methods of application of Fungicides

12. Methods of application of Bio agents

13. Koch's postulates

14,15&16.Preparation of fungicidal solutions, slurries and pastes and their applications

REFERENCES:

- Agrios, G.N. 2006. Plant Pathology. Elseveir Academic Press, New York.
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- Singh, R.S. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Vidyasekharan, P. 1993. Principles of Plant Pathology. CBS Publishers and Distributors, New Delhi.

PATH-2.7.2 DISEASES OF FRUIT, PLANTATION, MEDICINAL AND AROMATIC CROPS 3(2+1)

THEORY:

1,2&3. Etiology, Symptoms, Mode of spread, epidemiology and Integrated management of Fruit, Plantation, Medicinal and Aromatic crops *viz.,*

Mango–1.Powdery mildew, 2.Anthracnose, 3. Stem end rot, 4. Sooty mould, 5.Malformation, 6.Red rust, 7.Gummosis, Stem bleeding and Bark cracking 8. Post harvest diseases

4,5&6. Citrus - 1.Gummosis, 2.*Diplodia* Gummosis, 3. Twig blight, 4. Felt, 5. Pink 6. *Ganoderma* root rot, 7. Dry root rot, 8. Scab, 9.Powdery mildew, 10. Sooty mould,11. Canker, 12.Tristeza, 13.Greening, 14. Exocortis Viroid, 15. Psorosis, 16. Mosaic 17. Post harvest diseases

7&8. Grapevine - 1.Anthracnose, 2.Downy mildew, 3.Powdery Mildew, 4.*Alternaria* leaf spot, 5.Rust, 6. Dead arm,7. Bacterial leaf spot 8. Post Harvest diseases

9&10. Banana – 1. Panama Wilt, 2.Sigatoka leaf spot, 3.Anthracnose, 4. Cigar end rot, 5. Freckle leaf spot, 6. Moko disease, 7. Bacterial soft rot/ head rot/ tip rot, 8. Bunchy top, 9.Mosaic, 10.Infectious Chlorosis, 11.Banana streak mosaic, 12.Bract mosaicand 13. Post harvest diseases

11. Guava - 1. Canker 2. Wilt 3. Anthracnose 4.Red rust and 5. Post Harvest diseases

12. Sapota - 1. *Phavopleospora* leaf spot, 2.*Pestalotia* leaf spot, 3.Flat limb, 4. Fruit rots and 5. Post Harvest diseases

13&14.Papaya - 1.Damping off / Foot rot, 2. Anthracnose, 3.Powdery mildew, 4.*Alternaria* leaf spot, 5.*Phytophthora* root rot, 6. Ring spot Virus, 7. Mosaic, 8.Leaf curl 9. Post harvest diseases

15. Pomegranate - 1. *Cercospora* leaf spot, 2.Anthracnose, 3.*Phomopsis* fruit rot, 4. Bacterial leaf spot 5. Post harvest diseases

16. Ber - 1. Powdery mildew, 2.Sooty mould, 3.*Alternaria* leaf spot

Pine apple – 1. Heart rot & Root rot, 2. Base rot3. Wilt

17. Apple - 1. Scab, 2.Powdery mildew, 3.Fire blight, 4.Crown gall, 5.Mosaic6. Post harvest diseases

18,19&20.Jack fruit – 1. Die back 2. *Rhizophus* fruit rot

Custard Apple – 1.Anthracnose 2.*Glomerella* fruit rots

Aonla – 1.Rust 2. Anthracnose

Peach – 1.Leaf curl 2.Rust 3. Scab

Strawberry – 1.Anthracnose 2. Wilt 3. *Rhizophus* rot

Pear**,** Plum, Almond, Walnut – List out the important diseases

21. Coconut – 1. Bud rot 2. *Ganoderma* root rot 3. Stem bleeding 4. Grey blight 5. Tatipaka

Arecanut – 1.Fruit rot/ Mahali/ Koleroga 2. Foot rot / *Ganoderma* root rot

22. Oil Palm – 1. Nursery diseases 2. Bud rot 3. Basal stem rot 4. Bunch rot 5. Spear rot

23. Coffee – 1. Rust 2. Black rot

Tea – 1. Blister blight

24. Cashew – 1. Anthracnose 2. Pink disease

Cocoa – 1.*Phytophthora* blight 2. Charcoal pod rot 3. Swollen shoot 4. Black pod rot, Rubber – 1. Root rot 2. Powdery mildew

25. Betelvine – 1. *Phytophthora* root rot 2.*Sclerotium* foot rot 3. Bacterial leaf spot 4. Powdery mildew 5. Mosaic
Black Pepper – 1.*Phytophthora* foot rot 2. Anthracnose/ Pollu disease

26. Mint – 1. Stolon rot 2. Rust 3.*Alternaria* leaf blight 4. *Verticillium* wilt 5. Powdery mildew
Opium - 1.Downy mildew 2.*Alternaria* leaf spot 3.Powdery mildew 4. Mosaic

27. Neem – 1.Twig blight
Pyrethrum – 1.Damping off 2. Wilt 3. Rust 4.Leaf blotch 5. Grey mould
Senna – 1.Damping off 2. Leaf spot

28&29.Hemp**,** Belladona, Camphor, Costus, Crotolaria, Datura Dioscorea, *Solanum khasianum, Tephrosia*– List out the important diseases

30,31&32.Integrated disease management of Post-harvest diseases of Fruit, Plantation, Medicinal and Aromatic Crops.

PRACTICALS:

1. Diseases of Mango
2. Diseases of Citrus
3. Diseases of Grapevine
4. Diseases of Banana
5. Diseases of Guava and Sapota
6. Diseases of Papaya
7. Diseases of Pomegranate
8. Diseases of Peach, Pear and Plum
9. Diseases of Ber, Fig and Phalsa
10. Diseases of Apple, Custard apple
11. Diseases of Cashew, Jack fruit and Pine apple
12. Diseases of Coconut
13. Diseases of Arecanut
14. Diseases of Oil palm and Rubber
15. Diseases of Coffee and Tea
16. Diseases of Medicinal and Aromatic plants

REFERENCES:

- Verma, L. R. and Sharma, R.C. Diseases of Horticultural Crops, Indus Publishers
- Kulkarni, S. and Yashoda, R.H. Diseases of Plantation Crops and their management, Agrotech publication Academy.
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PATH-3.7.1 DISEASES OF VEGETABLE, ORNAMENTAL AND SPICE CROPS

3(2+1)

THEORY:

1&2. Etiology, Symptoms, Mode of spread, epidemiology and Integrated management of Vegetable, Ornamental and Spice crops *viz.*,
Tomato – 1. Early blight 2. Damping off 3. *Cercospora* leaf spot 4.*Stemphylium* leaf spot 5.*Septoria* leaf spot 6.Anthracnose 7.Buck eye rot 8. Collar rot 9. Wilt 10. Bacterial leaf spot 11. Bacterial fruit canker 12. Tomato Spotted Wilt virus 13. Mosaic 14. Leaf curl

3. Brinjal - 1. Damping off 2.*Cercospora* leaf spot 3.*Alternaria* leaf spot 4.Collar rot 5.Bacterial wilt 6.*Phomopsis* blight and Fruit rot 7. *Verticillium* wilt 8. Little leaf

4. Chillies - 1. Damping off 2. Anthracnose/ Die- back Fruit rot 3. Powdery mildew 4.*Cercospora* leaf spot/ Frog eye leaf spot5. *Alternaria* blight 6. Wilts (*Sclerotial* wilts, *Fusarium* wilts,*Verticillium* wilts)

5. Bhendi – 1. Powdery mildew 2.*Cercospora* leaf spot 3.*Alternaria* leaf spot 4.*Fusarium* wilt 5. Yellow Vein mosaic virus.

6&7. Crucifers (Cabbage, Cauliflower, Knol-khol, Brussels Sprout, Radish) - 1. Damping off and Wire stem 2. Club root 3.White rust4.Powdery mildew 5.Anthracnose 6.Downy mildew 7.*Alternaria* leaf spot 8.Black rot 8.Black leg 9. Cabbage Yellows

8&9. Peas - 1.*Pythium* seed and root rot 2. Downy mildew 3.Powdery mildew 4.Rust 5.*Fusarium* wilt 6. Anthracnose 7.*Ascochyta* blight 8. *Cercospora* leaf spot 9.Bacterial blight 10.Pea Mosaic 11. Pea Enation

10. Beans- 1. *Cercospora* leaf spot 2.Rust 3.Powdery mildew 4.Anthracnose 5. Stem and Pod (Anthracnose) 6. Angular leaf spot 7.Halo blight 8.Bacterial wilt 9.Bacterial blight 10. Dry root rot 11. Bean common mosaic 12. Yellow Mosaic

11. Beet root - 1. Seedling disease of Beet and Sugar beet 2.*Cercospora* leaf spot 3.*Sclerotium* root rot and blight 4.*Phoma* blight and heart rot 5. Beet Yellows

12. Potato- 1. Late blight 2. Early blight 3. Common Scab 4.Sclerotium rot 5. Brown rot 6. Soft rot 7. Wart 8.Dry rot 9. Black leg and soft rot 10. Witches broom 11. Leaf roll 12.Potato Spindle tuber Viroid

13. Cucurbits - 1. Powdery mildew 2.Downy mildew 3.*Cercospora* leaf spot 4. Fruit rot/ Cottony leak 5.*Fusarium* wilt (Water melon, Musk melon) 6.Anthracnose 7.Angular leaf spot 8.Bacterial leaf spot 9. Mosaic

14. Carrot – 1. *Cercospora* leaf blight 2.*Alternaria* leaf blight 3.Powdery mildew 4.Bacterial blight & root scab 5. Soft rot 6. Yellows

15. Colocasia – 1. *Phytophthora* blight 2.*Pythium* rot
Sweet Potato – 1.White rust 2.*Fusarium* wilt 3. Soft rot or Pox disease

16. Amaranthus, Spinach, Sorrel, Portulaca– 1. White rust 2. Downy mildew 3.Damping off 4.Anthracnose 5.*Cercospora* leaf spot 6.*Phyllosticta* leaf spot 7. Wilt 8. Wilt 9. Rust 10. Mosaic
Fenugreek – 1.Collar rot 2.Powdery mildew 3.Leaf spot 4. Downy mildew

17. Basella – 1. *Cercospora* leaf spot 2. Black rot

Hibiscus – 1. Root and Stem rot 2. Leaf spot
Lettuce – 1.Downy mildew 2.Bacterial leaf spot 3.Head rot 4. Mosaic
Moringa – 1.Twig canker

18. Onion & Garlic – 1. Purple blotch 2.Downy mildew 3. Smut 4. Smudge 5. Neck rot and Bulb rot 6. Blast 7. *Stemphylium* blight 8. Rots (Soft rot, Slippery skin, sour skin, neck rot, brown stain, black mold and blue mold)
19. Ginger – 1. *Phyllosticta* leaf spot 2.Rhizome rot/ Soft rot 3.Banded leaf / sheath blight and Leaf blight 4. Bacterial wilt
    Turmeric – 1.*Taphrina* leaf blotch 2. Anthracnose/leaf spot 3.Rhizome rot/ Root rot (*Pythium*) 4. Rhizome rot (*Fusarium*)
20. Clove – 1. Sudden death 2. Acute die back 3. Sumatra disease
    Cinnamon - 1. Bark canker 2. Leaf spot and die back
    Nutmeg – 1. Die back and Fruit rot 2. Wilt 3. Leaf spot
    Cardamom: Small Cardamom – 1. Damping off 2.Azhukal disease 3. Mosaic
    Large Cardamom - 1.Foorkey disease 2. Chirkey disease
21. Coriander – 1.Powdery mildew 2. Stem gall
    Curry leaf – 1. *Phyllosticta* leaf spot 2.*Macrophoma* leaf spot 3. Dry root rot
    Cumin– 1.*Fusarium* wilt 2. Powdery mildew 3. Blight
22. Rose – 1. Die back 2. *Verticillium* wilt 3. Stem canker 4. Black spot 5.Powdery mildew 6.*Alternaria* leaf spot 7.Rust 8. Crown gall
23. Jasmine- 1. Rust 2.*Cercospora* leaf spot 3.*Alternaria* leaf spot 4.Anthracnose 5.*Phyllosticta* leaf spot 6. Mosaic
    Crossandra – 1.*Cercospora* leaf spot 2. Wilt 3. Anthracnose
24. Chrysanthemum – 1. *Septoria* blotch 2.Powdery mildew 3.*Cercospora* leaf spot 4.Grey mold 5.*Phyllosticta* leaf spot 6.Rust 7.*Fusarium* wilt 8. Bacterial blight 9.Chlorotic mottle10.Chrysanthemum stunt viroid.
25. Tuberose – 1. *Alternaria* leaf spot 2.*Macrophomina* leaf spot
    Marigold -1.*Cercospora* leaf spot 2.*Colletotrichum* leaf spot 3.Powdery mildew 4.*Alternaria* leaf spot 5. Flower blight
26. Asters – 1. Anthracnose 2.*Stemphylium* leaf spot 3.*Septoria* leaf spot 4.*Ascochyta* leaf spot 5. Stem Canker and leaf blight 6. *Alternaria* leaf spot 7. Wilt 8. Root rot and Foot rot 9. Phyllody 10. Aster Yellows
27. Gladiolus – 1. Wilt / Yellow/ Brown rot / Dry rot 2. Corm rot 3. Leaf spot and Corm Scab 4. Mosaic
28. Gerbera – 1. Anthracnose 2.*Phyllosticta* leaf spot 3.Powdery mildew 4.*Ascochyta* leaf spot 5. Blossom blight or Stalk rot 6. Foot and root rot 7. Bacterial blight 8.Mosaic 9. Chlorotic mottle
29. Carnation – 1. Damping off 2.*Alternaria* leaf spot 3.*Septoria* leaf spot 4.*Mycosphaerella* leaf spot 5. Wilt 6. Die back and Stem rot 7. Bacterial wilt
30. Orchids – 1. Black rot 2.*Phomopsis* leaf spot 3. *Cercospora* leaf spot 4.Brown rot 5. Anthracnose

31&32. Post harvest diseases of Vegetable and Ornamental Crops and their management practices

PRACTICALS:

1. Diseases of Tomato
2. Diseases of Brinjal
3. Diseases of Chillies/Capsicum
4. Diseases of Bhendi
5. Diseases of Cabbage & Cauliflower
6. Diseases of Peas and Beans
7. Diseases of Beet root
8. Diseases of Potato
9. Diseases of Cucurbits
10. Diseases of Carrot and Colocasia
11. Diseases of Spinach and Sweet potato
12. Diseases of Onion
13. Diseases of Garlic and Ginger
14. Diseases of Turmeric and other spices
15. Diseases of Rose
16. Diseases of Jasmine and other ornamental crops

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DEPARTMENT OF GENETICS AND PLANT BREEDING

GPBR-1.8.1 PRINCIPLES OF GENETICS &CYTOGENETICS 3(2+1)

THEORY:

1. History of Genetics, types of genetics, theories and hypothesis related to genetics. Relation of Genetics with other fields of science, scope and importance.
2. Physical basis of heredity
3. Gametogenesis and syngamy in plants
4. Study of Chromosome structure, morphology, number, types, karyotypes and ideogram.
5. Mitosis: Stages, importance.
6. Meiosis: Stages, importance. Differences between mitosis & meiosis
7. Mendel's contribution - Mendel's law of Segregation, monohybrid.
8. Mendel's Laws of inheritance : Di & tri-hybrid ratio
9. Deviation from Mendelian inheritance (Pleiotropism, penetrance – complete and incomplete, expressivity with examples).Reasons for success.
10. Gene interactions. Different types with example and test cross ratio.
11. Gene interactions. Different types with example and test cross ratio.
12. Types of gene action, Multiple Alleles-its characteristics, pseudoalleles.
13. Quantitative and qualitative traits; difference between them.
14. Multiple factor hypothesis with example-ear length in maize.
15. Cytoplasmic inheritances-its characteristics and features. Maternal effects

16&17. Linkage – definition, phases, linkage map, linkage group, number of linkage groups, types of linkage, linkage value, detection of linkage, significance of linkage.

18-19. Crossing over – types, theories, mechanism, factors affecting crossing over, coincidence & interference, calculation of crossing over percentage from test cross data, cytological basis of crossing over-experiment of stern in *Drosophilla.*

20&21. Sex determination: Definition, Sex chromosomes & different methods of sex determination, Sex linked, sex influenced & sex limited characters & theirsignificance.

22&23. DNA & its structure, functions, types, modes of replication &repair : Components of DNA, DNA double helix structure, forms of DNA- A,B,C & Z form; modes of replication- theories of DNA replication-conservative, Semi-conservative & dispersive, DNA repair-direct repair of DNA,Excision repair of DNA, very short patch repair, short patch repair, long patch repair, functions of DNA.

24. RNA & its structure, function & types; components of RNA, types & functions of RNA-rRNA, mRNA. Evidences to prove DNA and RNA as genetic material

25&26. Transcription, Translation, Genetic code & Outline of Protein Synthesis – Central Dogma, Process of Transcription, Genetic code – codon, characteristic of Genetic code, Process of Translation, Protein synthesis – ribosomes, process – initiation, elongation & termination.

27&28. Gene expression – Promoter gene, operator gene, induction gene, operon constitutive gene, Operon Model, Components of Operon- Regulator, Promoter, operator & structure gene, Model-induction & repression, example of lac operon; fine structure of gene-cistron, recon, muton.

29&30. Mutation: Introduction, types of mutation, Characteristics of mutation, classification of mutations; induction of mutation-physical and chemical mutagenesis, classification of mutagens, Detection of mutations – CLB method &

attached X-chromosome technique, significance of mutations.

31. Chromosomal aberrations: Numerical.
32. Chromosomal aberrations: Structural.

PRACTICALS:

1. Study of fixatives and stains.
2. Squash techniques.
3. Smear techniques
4. Demonstration of permanent slides and cell division in plant cells.
5. Identification of various stages of mitosis.
6. Identification of various stages of meiosis.
7. Pollen fertility and viability test.
8. Determination of gametes – Principles of dominance, recessive, back cross, test cross, incomplete dominance, co-dominace and lethal factors.
9. Solving problems on monohybrid genetic ratio with dominance and with incomplete dominance.
10. Solving problems on dihybrid ratio – dominance, incomplete dominance and test cross ratios and combination of one or two of the above.
11. Principles of Chi-square test.
12. Gene interactions – Dominant epistasis, recessive epistatsis and duplicate dominant epistasis.
13. Gene interactions – Duplicate recessive epistasis, additive epistasis, duplicate and recessive epistasis. Polymeric gene action.
14. Estimation of linkages using test cross, coupling and repulsion phase.

15&16. Estimation of linkages using three point test cross from F_2 data and construction of linkage maps.

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- B.D. Singh. Fundamental of Genetics. Kalyani. India
- Gupta, P.K. 1985.Cytology, Genetics and Cytogenetics. Rastogi Publication, India.

GPBR -2.8.1 PRINCIPLES OF PLANTBREEDING 3(2+1)

THEORY:

1. Plant Breeding: Definition, Aim, Objectives and Scope
2. History and development of plant breeding – Scientific contributions of eminent scientists. Landmarks and achievements in PlantBreeding in India and World.
3. Modes of reproduction – Asexual reproduction, sexual reproduction, Genetic consequences and its significance in PlantBreeding
4. Modesofpollination,Geneticconsequences–cultivatedcropswiththebotanical names belonging to self- pollinated, cross- pollinated crops and often cross- pollinated crops. Differences between self-pollinated andcross-pollinated.
5. Plantgeneticresources– Types,geneticerosion,genebanks,genesanctuaries,germplasm and itsconservation
6. Methods of plant breeding – Introduction and acclimatization, History of plant introduction, NBPGR and its activity, procedure of plantintroduction
7. Purposeofplantintroduction–types of introduction and achievements with horticultural examples
8. Selection- natural and artificial selection – Basic characteristics and requirements of selection – selection intensity, selection differential, heritability and genetic advance. Mass selection – Procedure, modification of mass selection, merits, demerits and achievements.
9. Johannsen'sPurelinetheoryanditsconceptsandsignificance–Originofvariation in pure lines and characters of purelines. Progenytest– Geneticbasisofpurelineselection–generalprocedureforevolving avarietybypurelineselection.Itsmerits,demeritsandachievements.Comparison between mass and pure lineselection.
10. Biometrics–Definition,componentsofgeneticvariationi.e.,additive,dominance and epistasis and theirdifferentiation
11. Hybridization – Aims and objectives, different types of hybridization and prerequisites and procedures andtechniques
12. Handlingofsegregatinggenerations–Pedigreemethod–Procedure,modification of pedigree method – Merits, demerits andachievements
13. Bulk method – Procedure, modification of bulk method, merits, demerits and achievements. Comparison between pedigree and bulkmethod.
14. Backcross method of breeding, its requirements and application, procedure for transfer of single dominant gene and transfer of single recessivegene. Merits, demerits and achievements of backcross breeding – Comparison between pedigree and backcross method – Multiline concept – Its definition anduses
15. Pollination control mechanisms: Self incompatibilityand its classification – Genetic basis of incompatibility – Heteromorphic, homomorphic, gametophytic and sporophytic system of incompatibility.
16. Pollination control mechanisms: Male sterility- different types – Genetic, Cytoplasmic and Cytoplasmic genetic male sterility. Its inheritance andmaintenance.
17. Utilization of male sterile lines in hybrid seed production – Their limitation, advantages anddisadvantages
18. Ideotype breeding: Ideotypes in major horticultural crops with examples
19. Marker Assisted Selection- advantages, disadvantages and applications in improvement of horticultural crops
20. Combining ability: *GCA* and *SCA* variances and effects
21. Population Genetics: Hardy Weinberg Law- Factors disturbing equilibrium inpopulations
22. Heterosis & inbreeding depression – Manifestation of heterosis – Genetical, physiological and biochemical causes ofheterosis
23. Conceptsandhypothesisofgeneticalcausesofheterosisinself,cross-pollinated crops
24. Inbreeding depression – Effects of inbreeding in different crops – Procedure for development of inbred lines and theirevaluation.

25. Exploitationofheterosis–HistoryofHybridvarieties-Importantstepsinproduction ofsingleanddoublecrosshybrids–BriefideaofhybridsinVegetablecrops
26. Synthetics and composites – Production procedures, Merits, demerits and achievements comparison- between Synthetics andcomposites in vegetable crops
27. Recurrent selection- Different types- Detailed procedure of simple recurrent selection and brief description of other recurrent selectionmethods
28. Methods of breeding for vegetatively propagated crops, clones, genetic variation within clone, clonal degeneration characteristic features of asexually propagated crops and clones – Methods of improvement of clonal crops, clonal selection, hybridization, problems in breeding of clonal crops, Merits, demerits andachievements of clonalselection.
29. Mutation breeding – Spontaneous and induced mutation –Mutagens. Procedure of mutation breeding for oligogenic and polygenic characters – Limitations andachievements
30. Breeding for quality- achievements in horticultural crops
31. Breeding for resistance of biotic and abiotic stresses.
32. Polyploidy breeding.

PRACTICALS:

1. Breeding objectives, Floral biology, Selfing, Emasculation and crossing techniques in Tomato, Chillies and Bhendi.
2. Breeding objectives, Floral biology, Selfing, Emasculation and crossing techniques in Bottle Gourd , Ridge Gourd and and Cucumber
3. Breeding objectives, Floral biology, Selfing, Emasculation and Crossing techniques in Mango and Guava
4. Determination of modes of reproduction in crop plants.
5. Handling of segregating generations in Pedigree method.
6. Handling of segregating generations in Bulk method.
7. Handling of segregating generations in Back crossmethod.
8. Field layout of experiments and field trials and maintenance of experimental records and registers in self and cross pollinated crops.
9. Demonstration of hybrid variation and production techniques.
10. Hardy Weinberg law and calculation.
11. Male sterility in horticultural crops.
12. Self incompatibility in horticultural crops.
13. Calculation of Heterosis, heterobeltiosis, economic heterosis and inbreeding depression.

14&15. Gene action, calculation of GCA and SCA Variances and effects.

16. Calculation of Variability, Heritability and Genetic Advance

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GPBR-2.8.2 ELEMENTARYPLANTBIOTECHNOLOGY 2(1+1)

THEORY:

1. Plant Biotechnology: concepts and applications in crop improvement
2. Plant Tissue Culture and Plant Genetic Engineering: History, scope and importance in Crop Improvement.
3. Totipotency and Morphogenesis - Definition, Importance of totipotency and morphogenesis.
4. Nutritional requirements of in-vitro cultures - General techniques of tissue and cell culture, Different composition of culture medium, components of tissue culture medium, importance of growth regulator in culture medium
5. Techniques of In-vitro cultures - Types of culture, Micro-propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture. Applications and Achievements;
6. Somaclonal variation - Introduction, causes, procedure and application in crop improvement.
7. Somatic embryogenesis - Types, direct and indirect embryogenesis, factors influencing somatic embryogenesis and synthetic seed production technology.
8. Protoplast isolation, types. Protoplast culture - Introduction, method of protoplast fusion, selection and products of somatic hybrids and application of somatic hybridization in crop improvement. Cybrids.
9. Genetic engineering – Concept. Vector and its types for gene transfer. Restriction enzymes, Recombinant DNA techniques – Gene cloning.
10. Direct and indirect methods of gene transfer. Transgenic plants and their applications.
11. Blotting techniques – Types, procedure,application, advantages anddisadvantages.
12. DNA finger printing - Introduction, Methodology. DNA based markers – RFLP, AFLP, RAPD, SSR, SNP and DNA Probes.
13. Mapping QTL – Introduction, concept, types, Mapping QTL – Future prospects. Marker Assisted Selection (MAS) and its application in crop improvement.
14. Over view of genomics, proteomics and metabolomics. Gene silencing.
15. Nanotechnology: Definition and scope, types of nano material and their synthesis, green synthesis. Tools and techniques to characterize the nano- particles.
16. Nano-biotechnological applications in horticultural crops with examples. Nano toxicology and safety.

PRACTICALS:

1. Requirements for plant tissue culture laboratory.
2. Techniques in plant tissue culture.
3. Media components and preparations.
4. Sterilization techniques and inoculation of various explants.
5. Aseptic manipulation of various explants.
6. Callus induction and plant regeneration.
7. Micro-propagation of important horticultural crops- Hardening and acclimatization of regenerated plants.
8. Anther, embryo and endosperm culture.
9. Somatic embryogenesis and synthetic seed production.
10. Isolation of protoplast and demonstration of culturing of protoplast.
11. Demonstration of isolation of DNA.
12. Demonstration of gene transfer techniques – Direct methods.
13. Demonstration of gene transfer techniques – Indirect methods.
14. Demonstration of Gel electrophoresis techniques.
15. Demonstration of confirmation of genetic transformation
16. Green synthesis of Nano particles and their size characterization.

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GPBR-2.8.3 BREEDING OF FRUIT, PLANTATION ANDORNAMENTAL CROPS 3(2+1)

THEORY:

1. History and importance of fruit breeding, distribution, domestication and adaptation of commercially important fruits. Variability for economics traits.
2. Fruit breeding history, significance, milestones and achievements.
3. Botanical description, breeding objectives and methods for Mango and achievements.
4. Botanical description, breeding objectives and methods for Guava and achievements.
5. Botanical description, breeding objectives and methods for Citrus species and achievements.
6. Botanical description, breeding objectives and methods for Banana and achievements.
7. Botanical description, breeding objectives and methods for Papaya and Sapota and achievements.
8. Botanical description, breeding objectives and methods for Watermelon and Musk melon and achievements.
9. Botanical description, breeding objectives and methods for Pomegranate and Custard apple and achievements.
10. Botanical description, breeding objectives and methods for Amla and Jamun and achievements.
11. Botanical description, breeding objectives and methods for Grape and Litchi achievements.
12. Clonal selection – importance and significance in Horticulture crops.
13. Mutation – importance of Bud mutation in Horticulture crops.
14. Mutagen – types of mutagens and their applications along with achievements in crop improvement
15. Marker assisted selection- Applications in horticultural crops and achievements.
16. Genetic engineering – role and importance in horticulture crops and achievements.
17. History and importance of Plantation crops. Introduction- achievements in Plantation crops
18. Botanical description, breeding objectives and methods for Tea and achievements.
19. Botanical description, breeding objectives and methods for Coffee and achievements.
20. Botanical description, breeding objectives and methods for Coconut and achievements.
21. Botanical description, breeding objectives and methods for Areca nut and achievements.
22. Pure line selection, Mass selection, Pedigree selection, Backcross breeding procedures in Horticulture crops.
23. Role of Heterosis and its exploitation. Biotechnology in flower crop improvement
24. Male sterility – Utilization in production of F_1 hybrids. History of improvement of ornamental crops.
25. Botanical description, breeding objectives and methods for Chrysanthemum and Tube rose and achievements
26. Botanical description, breeding objectives and methods for Rose and Jasmine achievements
27. Botanical description, breeding objectives and methods for Gaillardia, Dahlia and Crossandra and achievements
28. Botanical description, breeding objectives and methods for Gerbera and Gladiolus and achievements
29. Botanical description, breeding objectives and methods for Marigold, Lilium and China aster and achievements.
30. Breeding for disease resistance.
31. Production of open pollinated seed- Harvesting, processing and storage of seeds.

32. Seed certification- Procedure.

PRACTICALS:

1. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Mango.
2. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Banana.
3. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Citrus.
4. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Grape.
5. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Guava and Sapota.
6. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Papaya and Custard apple.
7. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Aonla and Ber.
8. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Litchi, Pomegranate and Jamun.
9. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Arecanut and Coconut
10. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Tea and Coffee.
11. Floral biology, pollen viability, emasculation and pollination procedures, hybrid seed germination, evaluation of segregating populations, mutation and polyploidy breeding in Rose, Jasmine, China aster and Marigold
12. Study of floral biology and pollination in important species and cultivars of flower crops.
13. Techniques of inducing polyploidy and mutation in major ornamental crops.
14. Production of pure and hybrid seeds in flower crops.
15. Harvesting, conditioning and testing of seeds.
16. Practices in seed production methods of ornamental crops.

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GPBR-3.8.1 BREEDING VEGETABLE, TUBER AND SPICE CROP 3(2+1)

THEORY:

1. Classification of plants, Botanical description, Floral biology, Emasculation and Pollination techniques in important Horticulturecrops
2. Breeding objectives and important concepts of breeding self and cross pollinatedcrops
3. Breeding objectives and important concepts of breeding vegetative propagatedcrops
4. Plantgeneticresources–germplasm–differenttypesofplantgeneticresources–genepool–typesofgenepools–geneticerosion.Centre'soforiginanddiversity, Centre's of origin for differentcrops.
5. Domestication – selection under domestication – types of selection patterns of evolution in cropplants
6. Activities in germplasm conservation – collection – conservation – evaluation – cataloguing – multiplication and distribution – utilization in cropimprovement.
7. Germplasm conservation – in situ and ex site-gene banks and gene sanctuaries – cryopreservation. Organizations associated with germplasm. IBPGR, NBPGR and crop specific internationalinstitutions.
8. Polyploidy-Auto and Allo polyploidy-Their applications and limitations in horticultural crop improvement.
9. Breeding for insect resistance – types of insect resistance, nature and genetics, sources of resistance – methods of breeding, screening techniques – advantages and problems in breeding for insect resistance andachievements.
10. Breeding for disease resistance – vertical and horizontal resistance – mechanism of disease resistance, genetics and sources of resistance. methods of breeding and testing for disease R. problems in breeding for disease R andadvantages.
11. Breedingfordroughtresistance–droughtresistance,genetics,sourcesofdroughtresistance,breedingmethods, difficulties inbreeding.
12. Origin and distribution of species, wild relatives and forms ofTomato
13. Breeding objectives and procedures / methods for development ofTomato
14. Hybrids and varieties inTomato
15. Breedingobjectivesandprocedures/methodsfordevelopmentofhybrids/varieties inBrinjal
16. Origin and distribution of spices, wild relativesandforms. Breedingobjectives and procedures / methods for development of hybrids / varieties inBhendi
17. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties inCapsicum
18. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties inChilli
19. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties in Cucurbits (Cucumbers)
20. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties in Cucurbits (Gourds)
21. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties in Cucurbits (Melons).
22. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties inCabbage
23. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties inCauliflower
24. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties in Tuber crops – Potato

25. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties in Tuber crops – Sweet Potato
26. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties inCarrot and Radish
27. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties in Spice crops – Ginger
28. Origin and distribution of spices, wild relatives and forms. Breeding objectives and procedures / methods for development of hybrids / varieties inTurmeric
29. Breeding procedures for development of hybrids/varieties in various crops
30. Genetic basis of stability: Genotype X Environmentinteraction
31. Marker Assisted Selection- markers- applications and achievements in crop improvement
32. Breeding for quality Improvement of horticultural crops.

PRACTICALS:

1. Breeding objectives, Floral biology, selfing, emasculation and crossing technique inTomato
2. Breeding objectives, Floral biology, selfing, emasculation and crossing technique inBrinjal
3. Breeding objectives, Floral biology, selfing, emasculation and crossing technique inBhendi
4. Breeding objectives, Floral biology, selfing, emasculation and crossing technique in Chilli
5. Breeding objectives, Floral biology, selfing, emasculation and crossing technique inCucubits
6. Breeding objectives, Floral biology, selfing, emasculation and crossing technique inPotato
7. Methods for creation of variability inTurmeric
8. Methods for creation of variability inGinger
9. Working out phenotypic and genotypic variability, heritability and genetic advance.

10&11.Calculation of general combining ability, specific combining ability variances and effects

10. Calculationof heterosis, heterobeltiosis and standard heterosis.
11. GxE interaction (Stability analysis)
12. Preparation and use of chemical and physical mutagens
13. Polyploidy breeding and chromosomal studies
14. Techniques of F_1 hybrid seed production.

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DEPARTMENT OF AGRONOMY AND SOIL SCIENCE

ASSC 1.9.1 FUNDAMENTALS OF SOIL SCIENCE 2(1+1)

THEORY:

1. Introduction- Evolution and origin of earth, soil, land and landscape, functions of soil, branches of soil science. Concepts of soil, pedological and edaphalogical concepts of soil.Components of soil-mineral matter, organic matter, water and air.
2. Rocks-Formation, classification-igneous rocks, their classification based on mode of origin and silica content. Sedimentary rocks-formation, classification.Metamorphic rocks- formation, agents causing metamorphosis and classification.
3. Minerals – Primary, secondary, essential, accessory, light and heavy minerals.Primary minerals – quartz, feldspars, micas, pyroxenes, amphiboles and olivine
4. Weathering of rocks and minerals – Types of weathering, physical- agents and their role, chemical weathering processes and biological weathering- Role flora and fauna in weathering process.
5. Soil formation- soil forming factors-active and passive factors-their role in soil formation. Pedogenic processes – Eluvition, Illuviation, Humification, Calcification, Laterization, Podzolisation, Salinization, Alkalization, Pedoturbation and Gleization.Soil profile – Detailed description of a theoretical soil profile.
6. Soil taxonomy- purpose, salient features, diagnostic horizons- epipedons, endopedons and Soil orders. Important soil groups of India and Telangana.
7. Soil physical properties – nature and properties of soil separates, soil texture – definition and various textural classes in soil. Mechanical analysis-methods- Stoke's law- assumptions and limitations- importance and significance of soil texture in agriculture.
8. Soil Structure – definition-classification based on type, class and grade of soil structure. Evaluation. Importance of soil structure and its management. Density of soil -Bulk density and particle density – porosity- importance- calculation of porosity.
9. Soil consistency- forms of consistence-Atterberg's limits of soil consistency. Importance of soil consistency and its significance. Soil colour- components, its determination-Munsell colour chart, importance and significance of soil colour.

10&11. Soil water- components of soil water potential-soil moisture constants – field capacity, wilting coefficient, hygroscopic water and saturation, available water and pF concept. Determination of soil moisture content – gravimetric method, Tensiometer and neutron probe.Soil water movement- saturated and unsaturated flow- Darcy's law and Poiseuille's' law. Infiltration –factors influencing infiltration rate, importance.

12. Soil air – composition, movement of air or gaseous exchange, soil aeration, influence of soil air on plant growth, soil properties and nutrient availability. Measurement of Oxygen diffusion rate (ODR)-measures to improve soil aeration-aeration porosity, management of soil air.
13. Soil temperature – sources, thermal properties of soil, influence of soil temperature on plant growth. Factors influencing soil temperature, management of soil temperature and measurement of soil temperature.Soil reaction-pH, soil acidity, alkalinity, buffering mechanism, effect of soil reaction on nutrient availability and plant growth.
14. Soil colloids – Definition. General properties – shape, surface area, electrical charge adsorption, flocculation, deflocculation, plasticity, cohesion, swelling and shrinkage, Tyndall effect and Brownian movement. Classification of colloids, sources of charge on soil colloids. Ion exchange – Cation and anion exchange capacities of soil.Importance of CEC in agriculture.
15. Soil organic matter - various sources. Composition, compounds in plant residues, their decomposability. Humus-definition, Importance of soil organic matter and humus. Carbon: nitrogen (C: N) ratio, Significance of C: N ratio. Soil biology-types of organisms in soil and their important characters- beneficial and harmful effects of soil organisms.

16. Soil pollution- definition-kinds of soil pollution-sources of pollution-organic and inorganic sources. Effects and control of soil pollution, various ways- landfills, treatment of industrial wastes, judicious use of fertilizers and pesticides.

PRACTICALS:

1. Study of soil sampling tools, collection and processing of soil sample
2. Description of soil profile in field
3. Determination of soil texture by feel method.
4. Determination of Soil texture by bouyoucos hydrometer method.
5. Determination of bulk density, particle density and porosity of soil (cylinder method).
6. Determination of bulk density by core sampler and wax coating method.
7. Determination of soil moisture content by gravimetric and volumetric method.
8. Determination of soil colour using Munsell colour chart.
9. Determination of infiltration capacity of soil by double ring infiltrometer method
10. Determination of pH and Electrical conductivity of soil
11. Determination of Organic Carbon content in soil
12. Determination of Cation Exchange Capacity of soil
13. Determination of hydraulic conductivity of soil
14. Preparation of soil water extract
15. Introduction to colorimetry and flame photometry
16. Determination of sodium and potassium in soil water extract

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- Jackson, M. L. 2012. Soil Chemical Analysis: Advanced Course, Scientific Publisher.

ASSC-1.9.2 AGROMETEOROLOGY & CLIMATE CHANGE 2(1+1)

THEORY:

1. Agricultural Meteorology- Introduction, definition of meteorology, scope and practical utility of Agricultural meteorology. Composition and structure of atmosphere. Definitions of weather and climate, aspects involved in weather and climate.
2. Atmospheric Temperature – Introduction, Temperature and Heat definitions, Isotherms, horizontal and vertical temperature variations in the atmosphere – cardinal temperatures – air temperature and crop production and its importance on plant life. Low air temperature and plant injury; high air temperature and plant injury – soil temperature – Factors effecting soil temperature.
3. Solar radiation- Definition, introduction of electromagnetic spectrum and functions of light, solar constant, net radiation, black radiation, emissivity, absorptivity, reflectivity, transmissivity and albedo.
4. Definition of atmospheric pressure, cyclones and anti cyclones – wind definition-effect of wind on crops – Land and sea breezes – Mountain and valley winds. Atmospheric Humidity and its expression; Saturation; Effect of humidity on crops
5. Evaporation and transpiration, definitions – Factors effecting rate of evaporation and transpiration.
6. Monsoons- Definition, origin of South West and North East monsoons and their occurrence their impact on farm operations.
7. Drought Definition – Types of drought –Effect of drought on field crops – Management of drought. Precipitation and Condensation – definition, different farms of precipitation and condensations artificial rain making. Precipitation and Condensation – definition, different farms of precipitation and condensations artificial rain making.
8. Weather disasters and management – rainfall, heat and cold waves, wind storms, hail storms, thunder storms and dust storms, Tornadoes, defective insolation. Weather forecasting- Applications and utility – Synoptic charts, reports and symbols.
9. Climate change-causes. Global warming-causes and remote sensing.
10. Effect of climate change on horticulture. Past and future changes in greenhouse gases within the atmosphere. Sources and sinks for greenhouse gases.
11. Atmospheric chemistry. Plants sense and respond to changes in CO2 concentration. Measurement of short-term effects and mechanisms underlying the observed responses in C_3 and C_4 species. Plant development affected by growth in elevated CO_2.
12. Physiology of rising CO_2 on nitrogen use and soil fertility, its implication for production. Methodology for studying effect of CO_2. Change in secondary metabolites and pest disease reaction of plants.
13. The mechanisms of ozone and UV damage and tolerance in plants.
14. Increased temperature and plants in tropical/sub-tropical climates- effect on growing season, timing of flowering, duration of fruit development and impacts on crop yields and potential species ranges, interaction of temperature with other abiotic/biotic stress.
15. Mitigation strategies and prospects for genetic manipulation of crops to maximize production in the future atmosphere.
16. Modifying Rubisco, acclimation, metabolism of oxidizing radicals, and sink capacity as potential strategies.

PRACTICAL:

1. Visit to Agro meteorological observatory
2. Calculation of local mean time
3. Handling of agro meteorological instruments and weather data recording

4. Measurement of total solar radiation, long and short wave radiation
5. Measurement of Cloud Cover
6. Measurement of bright sunshine hours
7. Measurement of maximum and minimum temperatures
8. Measurement of soil temperature
9. Measurement of dew point temperature
10. Determination of vapour pressure and calculation of relative humidity
11. Measurement of atmospheric pressure
12. Measurement of wind direction and wind speed
13. Measurement of Precipitation
14. Measurement and determination of evaporation
15. Processing, tabulation, presentation of weather data
16. Analysis of rainfall data and probability calculations

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- D.Lenka, 2006. *Climate, Weather and Crops in India*. Kalyani Publishers, New Delhi.
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- Mavi, H.S.1985. *Introduction to Agro meteorology*. Oxford&IBH PublishingCo.,New Delhi.

ASSC - 1.9.3 WATER MANAGEMENT IN HORTICULTURAL CROPS 2 (1+1)

THEORY:

1. Importance of water, water resources in India.Area of different crops under irrigation.
2. Function of water for plant growth, plant water potential, effect of moisture stress on crop growth
3. Soil-plant water relationship, Available and unavailable soil moisture – distribution of soil moisture – water budgeting – rooting characteristics – moisture extraction pattern
4. Water requirements of horticultural crops, ET classification, direct methods
5. Climatological approaches for estimating water requirement, factors for crop growth stages
6. Critical stages of crop growth for irrigation.
7. Irrigation scheduling – different approaches based on Plant physiology and soil water status
8. Irrigation scheduling based on climatological approach and IW/CPE ratio
9. Methods of irrigation – surface and sub-surface methods.
10. Pressurized methods viz., sprinkler and drip irrigation -components, their suitability, merits and limitations.
11. Layout of different irrigation systems – drip and sprinkler & Layout of underground pipeline system
12. Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; design of sprinkler irrigation system: layout selection, sub-main and main pipe line, design steps; selection of pump and power unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency
13. Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patters, irrigation requirement, emitter selection, design steps; necessary steps for proper operation of a drip irrigation system; maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment
14. Concept of fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.
15. Water Use Efficiency and economic use of irrigation water
16. Water management in problem in soils, quality of irrigation water, irrigation management practices for different soils and crops.

PRACTICALS:

1. Measurement of irrigation water by using water measuring devices
2. Use of common formula in irrigation practices

3&4. Layout for different methods of irrigation- Observations and practicing land shaping and study of land leveling implements Layout for surface method and sub surface method of irrigation.

5. Measurement of soil moisture - Estimation of soil moisture constants and water holding capacity for different soils
6. Measurement of soil moisture 7. Scheduling of irrigation – preparation of schedule by different approaches for annuals, perennials under different methods of irrigation and climate -soil type scheduling of irrigation, different approaches
8. Practicing the use of instruments in irrigation practice - Tensiometer, Electrical resistance blocks, Pressure plate method, etc.
9. Estimation of irrigation efficiency and soil moisture conservation practices for increasing WUE
10. Estimation of water requirement for horticultural crop
11. Irrigation planning and scheduling for the water resources available
12. Working out Irrigation scheduling based on soil type and climatic requirements for horticulture crops

13. Layout for sprinkler method – Study of different components of sprinkler irrigation system; design and installation of sprinkler irrigation system; determination of precipitation pattern, discharge and uniformity coefficient; cost economics of sprinkler irrigation system
14. Layout for drip method- Study of different components of drip irrigation; design and installation of drip irrigation system; determination of pressure discharge relationship and emission uniformity for given emitter; study of different types of filters and determination of filtration efficiency; determination of rate of injection and design of irrigation and fertigation schedule for crops;
15. Field visit to micro irrigation system and evaluation of drip system; cost economics of drip irrigation

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- Choudhary M.L and Kadam U.S 2006. Micro irrigation for cash crops Westville Publishing House.

ASSC-2.9.1 SOIL FERTILITY AND NUTRIENT MANAGEMENT 2(1+1)

THEORY:

1. Introduction to soil fertility and productivity - factors affecting
2. Essential plant nutrient elements (Macro & Micro nutrients) - Primary (N, P & K) nutrient elements transformations, availability, functions, deficiency symptoms and corrective measures
3. Secondary (Ca, Mg & S) nutrient elements transformations, availability, functions, deficiency symptoms and corrective measures
4. Micro nutrient elements transformations, availability, functions, deficiency symptoms and corrective measures
5. Luxury consumption, nutrient interactions, visual diagnosis, plant nutrient toxicity symptoms and remedies measures
6. Acid and calcareous soils - characteristics and management
7. Salt affected soils - characteristics and management
8. Soil organic matter, Role of microorganisms in organic matter decomposition and humus formation
9. Importance of C : N ratio and pH in plant nutrition and soil buffering capacity
10. Soil fertility evaluation methods, critical limits of plant nutrient elements
11. Soil test crop response and target yield concept
12. Manures and fertilizers classification and manufacturing process
13. NPK fertilizers – composition and application methods Secondary & micro nutrient fertilizers
14. Biofertilizers - Types of biofertilizers and advantages & disadvantages
15. Nutrient use efficiency and Management, Integrated Nutrient Management.
16. Fertilizer control order. Properties and fate of major and micro nutrients in soils and Effect of potential toxic elements in soil productivity

PRACTICALS:

1. Analysis of soil for organic carbon content (OC) and organic matter
2. Determination of Calcium and Magnesium in soil
3. Determination of Sulphur in soil
4. Gypsum requirement of saline and alkali soils
5. Lime requirement of acid soils
6. Sampling of organic manure and fertilizer for chemical analysis
7. Physical properties of organic manure and fertilizers
8. Estimation of ammonical & nitrate nitrogen in nitrogenous fertilizer
9. Estimation of total Nitrogen in Urea and Farm yard manure.
10. Estimation of water soluble P_2O_5, Ca and S in SSP, Lime and Gypsum.
11. Estimation of Potassium in MOP/SOP
12. Estimation of Zinc in Zinc Sulphate.
13. Visiting of fertilizer testing laboratory
14. Introduction to analytical chemistry and Preparation of standard solutions
15. Introduction to analytical instruments - their principles, calibrations and applications
16. Visit to vermicompost unit and preparation of compost.

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ASSC-2.9.2 SOIL, WATER AND PLANT ANALYSIS 2(1+1)

THEORY:

1. Methods of soil, water and plant sampling & processing for analysis
2. Characterization of hydraulic mobility - diffusion and mass flow
3. Renewal of gases in soil and their abundance
4. Methods of estimation of oxygen diffusion rate and redox potential
5. Use of radio tracer techniques in soil fertility evaluation
6. Soil micro-organisms and their importance
7. Saline soils their appraisal and management
8. Alkali and acid soils, their appraisal and management
9. Waterlogged and sandy soils, their appraisal and management
10. Chemical and mineral composition of horticultural crops
11. Leaf analysis standards, index tissue and interpretation of leaf analysis values
12. Quality of irrigation water
13. Radio tracer technology application in plant nutrient studies
14. Rapid tissue tests for plants
15. Management of poor quality irrigation water in crop management
16. Soil and water pollution

PRACTICALS:

1. Introduction to analytical chemistry
2. Collection and preparation of soil, water and plant samples for analysis
3. Determination of sodium adsorption ratio (SAR) and ESP in soil
4. Determination of available Nitrogen in soils
5. Determination of available Phosphorus in soils
6. Determination of available Potassium in soils
7. Determination of available Sulphur in soils
8. Estimation of available micronutrient elements in soils
9. Determination of pH and EC in irrigation water samples
10. Determination of Carbonates and bicarbonates in soil and irrigation water samples
11. Determination of Ca and Mg in soil and irrigation water samples
12. Determination of N, P, &K in plant samples
13. Determination of Ca, Mg &S in plant samples
14. Determination of micronutrients in plant samples
15. Determination of Na and K in irrigation water samples
16. Determination of Chlorides and Boron content in irrigation water samples

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- Mushtaq, A. Wan. 2014. *Soil, plant and water analysis manual*. Agrotech publishing company, Udaipur.

ASSC–2.9.3 WEED MANAGEMENT IN HORTICULTURAL CROPS 2(1+1)

THEORY:

1. Introduction, definition of weed, beneficial and harmful effects of weeds.
2. Classification of weeds-classification based on morphology, life cycle, habitat, origin, association, special features with examples.
3. Propagation of weeds – sexual – asexual – vegetative reproduction – rhizomes –root stocks – runners – stolen – suckers – offsets – tubers – bulbs – bulbils – stems and roots etc. – Dissemination (Dispersal) of weeds – dispersal of weed seeds and fruits – dispersal agents – wind and water – animal, man and manures – farm implements and silage. Dispersal of vegetative propagules.
4. Weed Biology-characteristic features of weeds-weed ecology-persistence of weeds climatic-edaphic (soil) and biotic factor-crop weed association with some important crops like rice, maize, wheat, jowar, pulses, groundnut, sugarcane, cotton and tobacco.
5. Crop-weed competition – principles – critical period of crop – weed competition – Allelopathy
6. Concepts of weed prevention control and eradication.
7. Methods of weed control physical, mechanical, cultural, chemical and biological methods of weed control – bio-herbicides – integrated weed management.
8. Herbicides – definition, advantages and limitations of herbicide usage in India.
9. Classification of herbicides based on chemical nature, time and method of application and type of formulation.
10. Nomenclature of herbicides – commonly available herbicides in India – Adjuvants– definition, their use in herbicide application (1) Surfactants; (2) Stabilizing Agents; (3) Solvents; (4) Humicants; (5) Stickers; (6) Activators; (7) Compatibility agents; (8) Drift control agents.
11. Introduction to selectivity of herbicides – Fundamental principles of selectivity differential absorption of herbicides; differences in morphology and growth habits of plants – differential translocation of herbicides – differential rate of deactivation of herbicides by plants;
12. Metabolism, reverse metabolism and conjugation of herbicides in plants – differential protoplasmic resistance – multifactor selectivity of herbicides in plants – Compatibility of herbicides with other agro chemicals.
13. Weed Management in vegetables – Leafy vegetables: Palak, Amaranthus, SoralMenthi, Coriander, Curry leaf; Solanaceous: Tomato, brinjal, chillies. pCucurbitaceae – Guards and melons Crucifers: Cabbage and cauliflower Peas and Beans: French bean, garden bean, cluster bean Tubers: Potato, yam, sweet potato Perennial vegetables: Little guard, pointed guard, drumstick.
14. Weed management in orchards: Mango, cashewnut, citrus, banana, guava, sapota, grape Weed management in plantation crops: Coconut, oil palm Weed management in spices: Ginger, turmeric &chillies
15. Weed management in nurseries, in Lawns, in flowering plants(Rose, Jasmine and Chrysanthemum).
16. Weed management in green houses – Problematic weeds – Nutsedge, Bermuda grass, Parthenium and their control.

PRACTICALS:

1. Identification of weeds
2. Survey of weeds in crop fields and other habitats
3. Herbarium preparation of weeds
4. Estimation of weed flora and calculation of Weed Control Efficiency and Weed Index
5. Study of crop-weed association, crop- weed competition and determination of critical period weed competition
6. Study of commonly available herbicidesin the market, their nomenclature and label information
7. Computation of herbicide dose
8. Study of herbicide application equipment and calibration
9. Calibration of herbicide application equipment
10. Application of herbicides by different methods for effective weed control and precautionary measures
11. Study of phytotoxic symptoms of herbicides in different crops
12. Biology of problematic weeds – Doob grass, Nut sedge, carrot grass.
13. Biology and control of parasitic weeds
14. Economics of weed control practices
15. Visit to Non cropped areas and Orchards
16. Visit to Problem areas and Farmers field

REFERENCES:

1. Crafts, A.S. and Robbins, W.W. 1973. *Weed Control*. Tata McGraw-Hill Publishing Co. Ltd.,New Delhi.
2. Gupta, O.P. 1984. *Scientific Weed Management*. Today and Tomorrow Printers and Publishers, New Delhi.
3. Gupta, O.P. 2015. *Modern Weed Management*. Agro Bios (India), Jodhpur.
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6. Ramamoorthy, K. and Subbian, P., *Predominant Weed flora in hill –ecosystems.* Agrobios(India), Jodhpur.
7. Rao, V.S. 2000. *Principles of Weed Science*. Oxford & IBH Publishing Co., New Delhi.
8. Subramanian, S., Mohammed Ali, A. and Jayakumar, R. 1991. *All About Weed Control*. Kalyani Publishers, Ludhiana.
9. Tadulingam, C. and Venkatnarayana, D. 1955. *A Handbook of Some South Indian Weeds.*Government Press, Madras.
10. Thakur, C. 1977. *Weed Science*. Metropolitan Book Co. Pvt. Ltd., New Delhi.

ASSC-3.9.1 ORGANIC FARMING 2(1+1)

THEORY:

1. Organic farming – Introduction - concept and definition – major aims – relevance in present context – options in organic farming – advantages and components of organic farming – organic production requirements.
2. Biological intensive nutrient management – definition – Organic manures : Characteristics, advantages and disadvantages.
3. Classification of bulky organic manures – FYM, sheep and goat manure, poultry manure, night soil, compost, sewage and sludge, concentrated organic manures – oil cakes, meat group of manures and guano.
4. Compost – Definition – Principles of composting – Methods of composting: Indore method, Bangalore method, Coimbatore method, NADEP compost, composting of coir pith and press mud.
5. Vermicomposting – Definition – advantages – materials for vermicomposting – procedure to prepare vermicompost – Requirements for vermicomposting – application of vermicompost.
6. Green manures – Characteristics of green manure crops – crops suitable for green manuring – Types and methods of green manuring – advantages and disadvantages of green manuring.
7. Biofertilisers – Definition – Types of biofertilisers – Nitrogen fixers, phosphate solubulising microorganisms – Mycorrhizal fungi – Methods of application of biofertilisers – Advantages and disadvantages with biofertilisers
8. Recycling of organic residues – Soil improvement though application of organic amendments.
9. Integrated diseases and pest management – Definition – Pest management methods – Physical methods: manipulation of temperature, moisture, light and air. Mechanical methods: Mechanical destruction (manual or mechanical), mechanical exclusion, light and pheromone traps.
10. Cultural methods – Field and plant sanitation, tillage operations, planting time, seed rate, spacing, crop rotation, trap cropping, growing of barrier crops, intercropping, bird perches, water and nutrient management.
11. Biological methods – Bio- pesticides – advantages – Predators, Parasitoids, Pathogens – Bacterial insecticides, viral insecticides, fungal insecticides
12. Botanicals – Pyrethrum, neem seed kernel extract neem seed powder, soluble neem formulations, oils, soaps, oil cakes
13. Weed management – Preventive methods – Physical/ Mechanical: Tillage, stale seed bed, hand weeding, mowing, flooding, mulching, burning, dredging and chaining, soil solarization,
14. IWM - Cultural methods: Smother crops, cover crops, crop rotation, plant density, sowing, nutrient, and water management – Biological methods – Criteria for a bio- agent – Kinds of bioagents – insects, competitive plants – Allelopathy.
15. Quality consideration, certification, labeling and accreditation process.
16. Marketing, exports, International and national policies in promotion of organic farming.

PRACTICALS:

1. Organic nursery raising of vegetables and ornamentals crops.
2. Layout and sowing of vegetables by students under organic farming concept
3. Recording of germination per centage, gap filling and thinning operations in individual plots
4. Vermicompost making
5. Methods of composting of crop residues and organic wastes
6. Application of bio-pesticides in individual plots (Tricho card, BT, NPV)
7. Bio-fertilizer production techniques and its application
8. Inter cultivation and other operations in vegetables

9. Preparation of neem products and study of other botanicals for pest and disease control.
10. Preparation of other botanicals for pest and disease control
11. Recording of yield attributes and yield
12. Study of quality parameters of organic products
13. Harvesting of vegetables in plots
14. Visit to organic farms
15. Grading and packing of fruits and vegetables
16. Post harvest management of vegetables

REFERENCES:

- A.K.Dahama. 2007. *Organic farming for sustainable agriculture*. Agrobios (India), Jodhpur.
- Arun. K. Sharma. 2011. *Handbook of Organic farming*. Agrobios (India), Jodhpur.
- S.P. Palaniappan and K.Annadurai. 2010. *Organic farming – Theory and Practice*. Scientific Publishers. Jodhpur.
- U.Thapa and P. Tripathy. 2006. *Organic farming in India- Problems and Prospects*. Agrotech publishing agency, Udaipur.
- G.K.Veeresh. 2006. *Organic farming*. Foundation Books. New Delhi.
- Purohit, S.S. 2006. *Trendsin Organic Farmingin India*. Agros Bios (INDIA), Jodhpur.
- Thampan, P. K. 1995. *Organic Agriculture*. Peekay tree Crops Development Foundation,Cochin, Kerala.
- Sathe, T.V.2004. *Vermiculture and Organic Farming*. Days Publishing House, New Delhi.

ASSC 3.9.2 INTRODUCTION TO MAJOR FIELD CROPS 2(1+1)

THEORY:

1. Classification and distribution of field crops, definition and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping, sustainable agriculture.
2. Rice introduction- origin –area and production climatic and soil varieties and hybrids for TS – Classification of plant types – rice nurseries – wet, dry, dapog and modified dapog, puddling – rice seasons in TS– Seeds and sowing direct seeding and transplanting
3. Systems of rice cultivation – upland, low land, SRI, aerobic rice – nutrient management (NPK, Zn, Iron and biofertilisers) – Steps for increasing fertilizer use efficiency in rice.
4. Water management- methods of irrigation – submergence vs flooding – weed management – Crop rotations – harvesting- threshing – processing – par boiling.
5. Wheat origin area and production – wheat growing zones of India – climate and soils Varieties– tillage seeds, and seedling – nutrient , water and weed management – crop rotations harvesting – threshing and processing – yield attributes and yield.
6. Maize – origin area and production – classification of maize – climatic and soils – varieties tillage seeds and seedling nutrient management water and weed management – crop rotations, harvesting, threshing and processing yield attributes and yield. Sorghum: Origin, area and production, growing seasons in TS – climatic and soils varieties tillage seeds and seedling nutrient – water and wed management crop rotations harvesting threshing and processing – yield attributes and yield and ratooning.
7. Importance of pulses – chickpea and pigeon pea: origin area and production – climatic soils varieties for TS. Tillage seeds and seedling nutrient water and weed management crop rotations – harvesting and storage – yield attributes and yield.
8. Blackgram, greengram and cowpea: Origin area and production – climate and soils – varieties tillage seeds and seedling nutrient, water and weed management – crop rotations – harvesting – and storage yield attributes and yield.
9. Importance of oilseeds – soybean: Origin area and production – climate and soils – Varieties – tillage seeds and seedling nutrient, water and weed management – crop rotations – harvesting – and storage yield attributes and yield. Groundnut : Origin area and production – characters of Virginia and Spanish species of groundnut – climate soils – varieties tillage seeds and seedling nutrient (gypsum application, importance of ca and S nutrition), Water and weed management – crop rotations harvesting and storage – quality characters.
10. Mustard and Gingelly: Origin area and production climate and soils varieties tillage seeds and seedling nutrient, water and weed management – crop rotations – harvesting and storage and yield attributes and yield.
11. Sunflower and safflower: Origin area and production climate and soils varieties tillage seeds and seedling nutrient, water and weed management – crop rotations – harvesting and threshing, processing- yield attributes and yield.
12. Cotton: Origin area and production -types of cotton- climate and soils varieties for TS- Tillage seeds and seedling, topping and boll shedding- nutrient, water and weed management, `crop rotations – harvesting , quality evaluation yield attributes and yield.
13. Sugarcane : Origin area and production , climate and soils varieties – tillage – seed material – methods of planting – blind hoeing – trash mulching – nutrient water and weed management – crop rotations – wrapping and propping – harvesting and ratoon crop management.
14. Fodder crop – quality characteristics of an ideal forage- Berseem, Lucerne, and Stylosanthus – Soils and seed bed preparation – varieties for TS – seed and seedling

nutrient and water management – time and method of harvesting – yield on wet and dry weight basis.

15. Para grass, napier grass and Anjan grass: Soils and seed bed preparation – varieties for TS. Seed and seedling nutrient and water management, time and method of harvesting – yield on wet and dry weight basis.
16. Green manure crops – daincha, sunhemp and pillipesara: seed rate and seedling nutrient management harvesting

PRACTICALS:

1. Allotment of individual filed for land preparation and sowing of crop
2. Calculation of seed rate and fertilizer requirement.
3. Thinning, weeding, gap filling and recording of germination per cent age.
4. Identification of crops, crop seeds and fodder crops
5. Rhizobium inoculation and seed treatment.
6. Preparation of cropping scheme to suit different farming situations.
7. Visit to wetland farm, observations on resource allocation, recycling of inputs and Economics.
8. Visit to dry land farm, observations on resource allocation, recycling of inputs and Economics
9. Visit to garden land farm, observations on resource allocation, recycling of inputs and Economics.
10. Time and method of fertilizer application.
11. Study of agronomic characters of pulses
12. Study of agronomic characters of cereals
13. Study of agronomic characters oilseeds and fodder crops.
14. Harvesting of crops in individual fields.
15. Participation in post harvest operations and recording yield.
16. Visit to forage production farm to study the ongoing experiments.

REFERENCES:

- B. Gurarajan, R.Balasubramanian and V.Swaminathan. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.
- Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICAR Publication.
- Rajendra Prasad. Textbook of Field Crops Production – Food grain Crops. Volume I ICAR Publication.
- S.R.Reddy. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.
- S.S.Singh. 2005. Crop Management. Kalyani Publishers, New Delhi.
- Chidda Singh 1983. Modern Techniques of raising Field crops. Oxford & IBH, Publishing Co.,New Delhi
- Rajendra Prasad 2002. Text Book of Field crops Production, ICAR, New Delhi.
- Reddy, S.R. 2004. Agronomy of Field crops, Kalyani Publishers, Ludhiana.
- Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production South Asian Publishers, New Delhi.

ASSC 3.9.3 INTRODUCTORY AGROFORESTRY 2 (1+1)

THEORY:

1. Forest and forestry – branches of forestry – history of forests in India & Telangana/ Andhra Pradesh, Forest education and research in India.
2. Social forestry– need for Social forestry – Objectives & Scope of social forestry –- Farm forestry –definition – Scope of farm forestry – Role of farm forestry in India – Management considerations in farm forestry –Tree species suitable for farm forestry and their characteristics
3. Shelter belts – Functional role of shelter belts/ wind breaks – Design criteria of wind breaks – Characteristic of trees species suitable for wind breaks
4. Agroforestry – Concept of agroforestry – definition – Importance of agro forestry in India- Scope & potential of agro forestry – benefits of agro forestry
5. Crop rotation system: Swedden system/ shifting cultivation / jhoom cultivation / podo cultivation – Taungya system.
6. Agroforestry systems – sub systems – classification – choice of species for agro forestry -Canopy management in agroforestry systems – Research organizations in agro-forestry-Overseas organizations – inter cropping systems in agroforestry – Advantages: & disadvantages
7. Agri-horti systems for drylands. –Problems of drylands –-Characteristics of trees for selection – Characters of intercrop – Agri- horti system in pre-bearing orchards –Agri-horti systems in rainfed situations /conditions – Agri horticulture in irrigated conditions.
8. Tree crop interactions: interaction types – economic and ecological interactions – Coconut based planting system (intercropping under coconuts) above ground parts and below interactions.
9. Nutrient cycling in agroforestry system – Pattern of nutrient cycling in different land use systems – Litter quality.
10. Home gardens –Type of Home gardens – structure of home gardens – Rooting pattern and configuration in Home gardens – Production of food from Home Gardens.
11. Horti-pastoral system – Importance of Horti-pastoral system: – Choice of fruit trees– Choice of Pasture species –Establishment Techniques for Pastures – Legumes pastures- Grass Pastures: – Pure Stands Vs Mixtures-Integration of Fruit Trees, pasture and livestock.
12. Evaluation of agro forestry system –Productivity evaluation: Land Equivalent Ratio and Harvest Index Sustainability Evaluation: – Adaptability Evaluation – Economic Evaluation: –NPV, BCR and IRR.
13. Agroforestry Diagnosis and Design –Key Features of D &. D – Procedures of AF Diagnosis & Design – macro D& D – micro D & D – Criteria of Good Agroforestry Design.
14. Multipurpose trees (MPTs) their management practices, economics of cultivation – nursery and planting (*Acacia catechu, Dalbergia sissoo,,Tectona, Populus).*
15. Multipurpose trees (MPTs)–*Morus, Grewia, Eucalyptus, Quercus* spp.
16. Multipurpose trees (MPTs)– Bamboo, tamarind, neem etc.

PRACTICALS:

1&2. Identification of tree species –fuel wood, fodder, wind breaks and shelter belts- road side plantations, flowering trees etc., (preparation of herbarium for each group).

3. Identification of tree seeds – seed collection, objectives – methods of seed collection seed extraction and storage.
4. Nursery practices for different tree species – different types of nursery bed – preparation of nursery beds – sowing – evaluation.
5. Seed viability tests, seed requirement calculation and seed treatment methods.
6. Visit to agro forestry fields to study the compatibility of MPTs with agri/ horticultural crops.
7. Evaluation of different agroforestry systems – productivity evaluation. Sustainability evaluation, adaptability evaluation.
8. Visit to agro-biodiversity Park.
9. Visit to social forestry plantations – railway line plantations.
10. Visit to social forestry plantations – canal plantations.
11. Visit to social forestry plantations –roadside and industrial plantations.
12. Rapid assessment of farmers need for green manures, fodders, fuel wood in selected villages.
13. Identification of important major/ minor forest products of different tree species.
14. Economics of marketing of products raised in agroforestry systems.
15. Measurement of tree height.
16. Tree diameter measurement at breast height (DBH) – timber –volume calculation methods

REFERENCES

- An Introduction to Agroforestry. First reprint in India–2008. Springer International Edition
- Tejawani, K.G. 1994. Agro forestry in India. Oxford & IBH, Publishing Co. Pvt. Ltd., New Delhi
- Luna, R.K. 1989. Plantation forestry in India. International Book Distributors, Dehradun.
- Leda Satish. 2006. Biodiesel and Jatropha Plantations. AGROBIOS, Jodhpur.
- Chaturvedi, A.N. and Khanna, L.S. 1982. Forest Menstruation. Reprinted in 2006. International Book Distributors, Dehradun
- Negi,S.S.2006. Forest Tree Seed. Prashant Gahlotat Valley printers and publishers, Dehradun.
- Chundawat and S K Gautam.1996. A text book of Agroforestry. Oxford and IBH Publishing company Pvt. Ltd.
- Ramachandran Nair, P.K. 1993. AnIntroductionto Agroforestry. First reprint in India–2008.Springer International Edition.
- Tejawani, K.G. 1994. Agro forestry in India. Oxford & IBH, Publishing Co. Pvt. Ltd., New Delhi.
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DEPARTMENT OF PLANT PHYSIOLOGY, BIOCHEMISTRY AND MICRO BIOLOGY

PPBM 1.10.1 INTRODUCTORY CROP PHYSIOLOGY 2(1+1)

THEORY:

1. Water Relations in Plants: Role of water in plant metabolism, Diffusion, Osmosis, Diffusion pressure deficit (DPD) Suction pressure, Imbibition and Plasmolysis.
2. Water potential and its components-Measurement of water potential by various methods in plants
3. Water uptake (passive and active) and Mechanism of water uptake
4. Ascent of sap, various theories proposed the mechanism of ascent of sap. Embolism
5. Transpiration-definition and importance, various modes of transpiration. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata.
6. Factors affecting transpiration. Concepts of Root pressure, Guttation and Stem bleeding.
7. Plant Nutrition: Criteria of essentiality, classification based on mobility in plants, requirement, uptake and biochemical function, mechanism of absorption
8. Physiological roles of nutrients in plant metabolism. Deficiency and Toxicity symptoms of plant nutrients
9. Biological Nitrogen Fixation- Formation of root nodules in leguminous plants Mechanism of biological nitrogen fixation
10. Photosynthesis, structure and function of chloroplast, Light reactions- cyclic and non-cyclic electron transfer,
11. Dark reactions-CO_2 fixation – C3, C4 and CAM metabolism, advantages of C4 pathway.
12. Photorespiration and its significance, Factors affecting photosynthesis.
13. Herbicide physiology: Definition of herbicide, Classification of herbicides based on various criteria.
14. Secondary metabolites: Terpenes, Phenols, Alkaloids and Role of secondary metabolites plant defense.
15. Stress Physiology: Drought- Mechanism of drought tolerance
16. Stress Physiology: Heat and Cold stress; mechanism of tolerance

PRACTICALS:

1. Preparation of standard solutions
2. Demonstration of osmosis by means of potato osmoscope
3. Measurement of root pressure
4. Measurement of water status in leaves, stem and root.
5. Measurement of water potential by various methods in plants
6. Measurement of stomatal frequency and index.
7. Measurement of transpiration by potometer method
8. Measurement of the rate of transpiration by cobalt chloride method
9. Transpiration and transpiration pull demonstration.
10. Measurement of absorption spectrum of chloroplastic pigments and fluorescence
11. Separation of chlorophylls, carotenes and xanthophylls by chemical method
12. Measurement of photosynthesis by Hill reaction
13. Leaf anatomy of C3 and C4 plants.
14. Study on movement of plants
15. Important physiological disorders in different fruit and vegetable crops and their remedial measures through application of nutrients and other methods.
16. Preparation of Herbarium for nutritional deficiencies in Horticultural Crops.

REFERENCES:

- S N Pandey and B K Sinha. Plant Physiology (4th edition). Vikas publication
- Salisbury and Ross. Plant Physiology
- Lincoln Tiaz and Eduardo Zeiger. Plant Physiology (5th edition)
- Dr V.K Jain, Fundamentals of plant physiology. S Chand Publications
- S. K Verma and Mohit Verma. A Text book of plant physiology, Biochemistry and Biotechnology. S Chand Publications
- R.K Sinha. Modern Plant Physiology
- Andrew H Cobb and John P H Reade. Herbicides and Plant Physiology (Wiley-Blackwell)
- S.V.Sai Prasad, Anjali Anand, BR Parihar and DC Saxena. Plant Physiology (New Vishal Publications)
- D.O.Hall and K K Rao. Photosynthesis (6th edn.). Cambridge University Press
- P Dwivedi and R S Dwivedi.Physiology of Abiotic Stress in Plants. Agrobios Publications

PPBM-1.10.2 ELEMENTARY PLANT BIOCHEMISTRY 3(2+1)

THEORY:

1. Scope and importance of Biochemistry in Horticulture.
2. Carbohydrates: Occurrences, Classification, and Structures.
3. Physical and Chemical properties of carbohydrates, isomerism and optical activity.
4. Reducing property, Reactions with acids and alkali, osazone formation.
5. Lipids: Classification, functions importance of fatty acids.
6. Triglycerides, essential fatty acids.
7. Physical and chemical properties of oils, Properties like saponification, hydrogenation, iodine number and acid number.
8. Rancidity, Phospholipids, types and importance.
9. Biochemistry and significance of secondary metabolites – Cynogenic glycosides, terpenoids, alkaloids, phenolic compounds and plant defence system.
10. Plant pigments: Structure and function of chlorophyll and carotenoids and sterols.
11. Basic structure and role of brassinosteroles in plants.
12. Proteins: Classification, function and solubility.
13. Amino acids structures and classification.
14. Essential amino acids, properties of amino acids, colour reactions, amphoteric nature and Isomerism.
15. Structure of proteins; Primary, Secondary, Tertiary and Quaternary.
16. Properties: like U.V absorption, immunological properties, denaturation and solubility, purification and reactions of proteins.
17. Structure and biological functions of Vitamins.
18. Enzymes: Classification and mechanism of action.
19. Factors affecting enzyme action
20. Immobilization of enzymes.
21. Enzyme inhibition and Industrial uses of enzymes.
22. Vitamins and minerals as co-enzymes/cofactors.
23. Metabolism: Carbohydrates metabolism, Glycolysis and TCA cycle.
24. Metabolism of lipids: Fatty acids oxidation and biosynthesis of fatty acids.
25. Electron transport chain (ETC), Bioenergetics of glucose and fatty acids.
26. Biochemistry of seed germination and development.
27. Biochemical composition and food values of various foods – like cereals, pulses, oil seeds, fruit and vegetables.
28. Biochemistry of fruit ripening
29. Nucleic acids: Structures and functions of nucleic acid.
30. Structure of DNA and Types of DNAs, Genetic code.
31. Types of RNAs and structures of RNAs. Packing of DNA into chromosome.
32. Replication, Transcription and Translation.

PRACTICALS:

1. Preparation of standard solutions and reagents
2. Carbohydrates qualitative reactions
3. Estimation of starch
4. Estimation of reducing and non reducing sugars from fruits
5. Amino acids: Reactions of amino acids
6. Proteins: Estimation of proteins by Lowry's method
7. Fatty acids: Estimation of free fatty acids
8. Determination of Iodine number of vegetable oils
9. Vitamins: Estimation of Ascorbic acid
10. Paper Chromatography
11. Thin Layer chromatography
12. Gas Liquid Chromatography (GLC)
13. High Performance liquid Chromatography (HPLC)
14. Electrophoresis of pigments extracted from flowers
15. Extraction of oil from oil seeds
16. Enzymes: Enzyme assay, Enzyme Immobilization

REFERENCES:

- Chittaranjan Sarangi. Elementary Plant Biochemistry for Horticulture. Jaya Publications
- J.L Jain, Sunjay Jain and Nitin Jain.Fundamentals of Biochemistry. S.Chand
- David L. Nelson and Michael Cox.Lehninger Principles of Biochemistry: International Edition
- U Satyanarayana and U. Chakrapani. Biochemistry (5^{Th} edition)
- Bob B. Buchanan, Wilhelm Gruissem and Russell L. Jones .Biochemistry and Molecular Biology of Plants
- Bose. Developments in Physiology, biochemistry &molecular biology of plants
- Voet, D and Voet, J. G. Biochemistry. John wiley &sons Incl. USA
- Sadashiv, S and Manickam, A 1996. Biochemical methods for Agricultural Sciences. New age International Publishers, New Delhi
- Rameshwar, A. Practical Biochemistry. Kalyani Publishers, New Delhi
- G. Nagaraj. Plants Biochemistry techniques and procedures. Nipa Publishers

PPBM - 1.10.3 INTRODUCTORY MICROBIOLOGY 2(1+1)
THEORY:

1. History and scope of Microbiology: The discovery of micro-organism. Spontaneous generation conflict - contribution of Antony Leuwenhoek, Francesco Redi, Lazzero Spalanzani, Franz Shultz, Schroder and Van Dush, Louis Pasture, John Tyndal. Role of Microbes in ferment and contributions of cagnaird Latour, Theodor Schwann, F. Kutzing and Louis Pasteur etc.,
2. Germ Theory of disease and contribution of Hippocrates, Louis Pasteur, Robert Koch, Pure culture methods by Joseph Lister, Robert Koch, Beijerinck, Winogradsky, Francois Appert, Schroder and Van Dush, John Tyndal Etc,. Protection against infection and contributions of Edward Jenner, F. Loeffler, Behiring, Kitasasto and Louis Pasteur Etc.,
3. Development of microbiology in India and composition of microbial world.
4. Distribution of micro organisms in soil.Microbial effect on organic and inorganic matter.
5. Microscopy and specimen preparation.The bright field microscope, fixation, dyes and Simple staining and differential staining.
6. Differences between prokaryotic and eukaryotic cells. Prokaryotic cell structure and function.
7. Types of culture media. Synthetic and non synthetic media, liquid and solid media, simple and enriched media, deferential, selective and minimal media etc., and Pre-culture techniques.
8. Nutritional groups of bacteria: Phototrophs, Chemotrophs, Autotrophs and heterotrophs. Parasites and Saprophytes
9. Microbial growth in models of bacterial, yeast and mycelia growth curve. Measurement of bacterial growth.
10. General properties of Viruses and brief description of bacteriophages. Bacterial genetics
11. DNA as genetic material. Bacterial Recombinations-Transduction, Conjugation and Transformation
12. Microbial association: Antibiosis, Symbiosis, intra- microbial and extra- microbial association.
13. Sterilization methods: Physical and chemical, Isolation of pure culture and preservation of culture.
14. Plant growth regulators and phototoxin production by micro- organisms, Plant growth promoting microorganisms.
15. Mushrooms - Economical importance, Industrially import microorganisms in large scale production and common microbial fermentation.
16. Mushrooms – edible and poisonous type, nutritive values, culturing and production techniques.

PRACTICALS:

1. Familiarization of glassware, chemicals and equipment of microbiology laboratory
2. Examination of stained cell by Simple staining
3. Examination of stained cell by Gram staining
4. Methods for sterilization
5. Nutrient agar preparation
6. Broth culture
7. Agar slopes
8. Steak plate method
9. Pour plate method
10. Turbid metric estimation of microbial growth
11. Mushroom culture
12. Spawn production
13. production of mushrooms
14. Mushroom harvesting
15. Packing of Mushroom
16. Storage of Mushroom

REFERENCES:

- Michael J Pelczar, E.C.S. Chan and Noel R Krieg. Microbiology (4th edition)
- Tejpal Dhewa. Introductory microbiology. ICAR, Newdelhi
- Seqeira, Tauro, Kapoor and Yadav. An Introduction to Microbiology
- Willey, Sherwood and Woolverton. Prescott's Microbiology (11th edition)
- R P Singh. Microbiology
- Michel Madigan. Brocks Biology of Micro Organisms (15th edition)
- David M. Sylvia, Jeffry J. Fuhrmann, Peter G Hartel and David A Zuberrer. Principles and applications of soil Microbiology
- William C Frazier Dennis C Westhoff. Food Microbiology.
- L E Casida. Industrial Microbiology
- Y. Nagaraju. Glimpses of Microbiology

PPBM – 3.10.1 Growth and Development of Horticulture Crops 2(1+1)

THEORY:

1. Growth and development-definitions, components, Different stages of growth, growth curves-sigmoid and double sigmoid
2. Growth analysis in horticultural crops. Components of growth analysis, advantages and disadvantages of growth analysis
3. Plant bioregulators- auxin basic functions, biosynthesis, transport in plant, Practical utility in Horticultural Crops
4. Plant bioregulators- gibberellin, basic functions, biosynthesis, transport in plant, Practical utility in Horticultural Crops
5. Plant bioregulators- cytokinin, basic functions, biosynthesis, transport in plant, Practical utility in Horticultural Crops
6. Plant bioregulators- ethylene basic functions, biosynthesis, transport in plant, Practical utility in Horticultural Crops
7. Plant bioregulators- Abscisic acid basic functions, biosynthesis, transport in plant, Practical utility in Horticultural Crops
8. Mechanisms of Abscission and Senescence of leaves, Programmed Cell Death (PCD)
9. Growth inhibitors and retardants, Novel plant growth regulators and their role in crop growth and development
10. Photoperiodism-long day, short day and day neutral plants, Role of Phytochrome in flowering: Vernalisation and it's applications in horticulture; Devernalization
11. Canopy development, Canopy Photosynthesis; Factots affecting canopy photosynthesis and productivity
12. Pruning and training; physiological basis of pruning and training
13. Physiology of fruit growth and development - flowering, factors affecting flowering, fruit setting, fruit thinning, fruit drop, and fruit ripening.
14. Physiology of ripening of fruits-climacteric and non-climacteric fruits.
15. Source and sink relationship; Mechanism of translocation of assimilates.
16. Physiology of seed development and maturation; Seed dormancy and bud dormancy, causes and breaking methods in horticultural crops.

PRACTICALS:

1. Preparation of herbarium for monocarpic, polycarpic, determinate and indeterminate growth types
2. Measurement of leaf area by various methods
3. Estimation of different growth analysis parameters in horticultural crops
4. Estimation of photosynthetic potential of Horticultural Crops
5. Preparation of plant growth regulator solutions
6. Bioassay for auxins and ethylene - Effect on root growth
7. Bioassay for gibberellins- hypocotyls elongation
8. Bioassay for kinetin (or cytokinins)- cotyledon enlargement and chlorophyll retention
9. Preparation of hormonal solutions and application to different types of cuttings for inducing rooting

10. Preparation of hormonal solutions and application to different fruits for promoting ripening
11. Preparation of hormonal solutions and application to different fruits and vegetable crops to control flower and fruit drop
12. Effect of light on plant growth and development
13. Seed viability tests
14. Seed vigour tests
15. Optimum conditions for seed germination
16. Breaking seed dormancy by mechanical and chemical methods.

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- F.P Gardner, R.B Pearce and Roger L. Mitchell. Physiology of Crop Plants. Scientific Publications
- M Acharya Chowdari and K K Gupta. Practical Plant Physiology
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- S. K. Verma. A Text Book of Plant Physiology (S. Chand & Company Ltd.)
- V. Verma. A Text Book of Plant Physiology (Emkay Publications).
- Dr. H.N. Srivastava. Plant Physiology and Metabolism (Pradeep Publications)
- Dr. B.B. Arora. Plant Physiology and Metabolism (Modern Publishers)
- Lalit M Srivastava. Plant growth and development Hormones and Environment

DEPARTMENT OF ENGLISH, STATISTICS AND SOCIAL SCIENCES

ESSC-1.11.1- ELEMENTARY STATISTICS AND COMPUTER APPLICATION

3(2+1)

THEORY:

1. Data – definition – Collection of data – Primary and secondary data – Classification of data – Qualitative and quantitative data.
2. Diagrammatic representation of data – uses and limitations – simple, Multiple, Component and percentage bar diagrams – pie chart.
3. Graphical representation – histogram – frequency polygon and frequency curve.
4. Measures of averages - Mean – median – mode – geometric mean – harmonic mean – computation of the above statistics for raw and grouped data - merits and demerits – when to use them-measures of location – percentiles – quartiles - computation of the above statistics for raw and grouped data.
5. Measures of dispersion - Range, Variance -Standard deviation – co-efficient of variation - computation of the above statistics for raw and grouped data.
6. Probability – Basic concepts-trial- event-equally likely- mutually exclusive – independent events, additive and multiplicative laws. Theoretical distributions-discrete and continuous distributions, Binomial distributions-properties.
7. Poisson Distributions - properties, Normal Distributions- properties.
8. Sampling-basic concepts- sampling vs. complete enumeration, parameter and statistic-sampling methods-simple random sampling and stratified random sampling.
9. Test of significance – Basic concepts – null hypothesis – alternative hypothesis – level of significance – Standard error and its importance – steps in testing. T-test – definition – assumptions – test for equality of two means-independent and paired T tests.
10. Attributes – Contingency table – 2x2 contingency table – Test for independence of attributes-test for goodness of fit of mendalian ratio.
11. Correlation – definition – Scatter diagram -Pearson's correlation co-efficient – properties of correlation coefficient.
12. Regression – definition – fitting of simple linear regression equation – testing the significance of the regression coefficient.
13. Design of experiments – basic concepts – treatment – experimental unit – experimental error - basic principle – replication, randomization and local control.
14. Completely randomized design – description – layout – analysis – advantages and disadvantages.
15. Randomized blocks design – description – layout – analysis – advantages and disadvantages.
16. Latin square design – description – layout – analysis – advantages and disadvantages.
17. Factorial experiments – factor and levels – types – symmetrical and asymmetrical – simple, main and interaction effects – advantages and disadvantages.
18. 2^2 and 2^3 factorial experiments in RBD – layout – analysis.
19. Split plot design – layout – ANOVA Table.
20. Strip plot design – layout – ANOVA Table.
21. Long term experiments – ANOVA table – guard rows – optimum plot size – determination methods.
22. Introduction to computers – components of CPU – arithematic logic unit – memory unit and control unit and their functions – application of computer in Agricultural Research.
23. Hardware – commonly available hardware and their functions – software – types – system software and application software – an introduction to DOS, Windows and Linux OS.
24. Programming languages – types – low level and high level programming languages. BASIC language and R statistical language– input/output statements – READ, DATA, INPUT and PRINT statements
25. Control statements – GOTO, IF statements – Loop Statement – FOR and NEXT statement - subscripted variable – simple programmes to calculate mean, standard deviation, simple correlation and simple linear regression equation using above

statements.

26. MS Office – introduction – MS WORD – creating a simple document – editing and printing of a document.
27. Spreadsheet – MSEXCEL – rows, columns and cell identification – workbook and a worksheet – using simple statistical functions like average, median, mode, variance and standard deviation – creation of bar and pie charts in Excel.
28. Presentation software – Power Point – creation of simple slides – slide show.
29. Visual Basic – introduction – integrated development environment (IDE) – properties, methods and events – variables – data types – working with forms – working with controls – dragging and dropping – message box.
30. Multimedia – introduction – multimedia hardware and storage devices – communication devices – multimedia software – presentation tools.
31. Tools for object generation, video and sound – audio file formats – video file formats.
32. Internet – introduction – network and types of network – LAN, WAN and MAN – advantages and disadvantages of net works – devices – hub, router and switch.

PRACTICALS:

1. Diagrammatic and graphic representation.
2. Measures of central tendency – mean, median, mode, geometric mean and harmonic mean for raw data.
3. Measures of central tendency – mean, median, mode, geometric mean and harmonic mean for grouped data.
4. Measures of dispersion – variance, standard deviation and coefficient of variation for raw data.
5. Measures of dispersion – variance, standard deviation and coefficient of variation for grouped data.
6. Selection of simple random sampling using lottery method and random numbers.
7. Student's t test – paired and independent t test.
8. Chi square test – test for association and goodness of fit and Calculation of Karl Pearson's correlation coefficient.
9. Fitting of simple linear regression of y on x.
10. Formation of ANOVA table for completely randomized design (CRD) with equal replication and comparison of means using critical difference values.
11. Formation of ANOVA table for randomized blocks design (RBD) and comparison of means using critical difference values.
12. Formation of ANOVA table for Latin square design (LSD) and comparison of means using critical difference values.
13. Simple programmes in BASIC and R software for calculation of mean and standard deviation.
14. Programmes in BASIC and R software for calculation of paired t test, independent sample t test and Z test.
15. MS Office – creation of document in WORD and Data anlysis tools using EXCEL.
16. Email – account creation, composing, sending mails with attachments and reading the mails received.

ESSC – 1.11.2 ECONOMICS AND MARKETING 3(2+1)

THEORY:

1. Economics – Nature and Scope – Definition – Division of Economics – Approaches to the Study of Economics
2. Basic Concepts in Economics – Good – Classification – Service – Utility – Characteristics and Classification – Wants – Characteristics and Classification – Wealth – Welfare
3. Economic systems – Capitalist – Socialist – Mixed economy
4. Consumption – Laws of Consumption – Engle's Laws of Family Expenditure
5. Theory of Consumer Behaviour – Measurement – Cardinal Approach – Law of Diminishing Marginal Utility – Definition – Assumptions – Explanation – Importance - Exceptions
6. Law of Equi-marginal Utility – Definition – Assumptions – Explanation – Importance – Limitations
7. Consumer Surplus – Meaning – Definition – Assumptions – Explanation – Importance – Difficulties in Measuring Consumer Surplus
8. Ordinal Approach – Indifference Curve – Definition – Explanation – Properties – Budget line – Consumer equilibrium
9. Demand – Demand Schedule and Curve – Market Demand – Law of Demand – Movement along the Demand Curve – Shift in Demand Curve
10. Elasticity of Demand – Types – Price, Income and Cross Elasticities – Degree of Elasticity of Demand
11. Supply – Supply Schedule and Curve – Market Supply – Law of Supply - Degree of Elasticity of Supply
12. Price determination – Market Equilibrium – Forecasting under various market structures
13. Theory of Firm – Land – Characteristics – Labour – Characteristics – Division of Labour
14. Theories of Population – Malthusian Theory – Proposition – Criticisms – Optimum Theory – Dalton's Formula for Maladjustment
15. Capital – Characteristics – Classification – Capital Formation
16. Enterprise/Organization – Forms of Business Organization – Merits and Demerits
17. Theories of Distribution – Rent – Economic Rent – Contract Rent – Quasi Rent – Scarcity Rent – Ricardian Theory of Rent – Modern Theory of Rent
18. Wages – Method of Wage Payment – Types of Wages – Theories of Wages – Subsistence Theory – Wage Fund Theory – Residual Claimant Theory – Marginal Productivity Theory – Modern Theory
19. Interest – Concepts - Theories of Interest – Productivity Theory – Waiting/ Abstinence Theory – Austrian or Agio Theory – Time Preference Theory – Liquidity preference Theory
20. Profit – Concepts – Theories of Profit – Rent Theory of Profit – Wage Theory of Profit – Dynamic Theory of Profits – Risk Theory of Profits – Uncertainty-bearing Theory of Profits – Innovations Theory – Monopoly Theory of Profits
21. Laws of Returns – Constant Returns – Increasing Returns – Decreasing Returns – Laws of Diminishing Marginal Returns
22. Cost Concepts – Fixed Costs – Variable Costs – Total Costs – Average Variable Costs – Average Fixed Costs – Average Costs – Marginal Costs
23. Marketing – Definition – Market Process – Need for Marketing – Role of Marketing – Problems and Suggestions of Marketing Horticultural Produce in India
24. Marketing functions – Primary functions – Physical functions – Exchange Functions and Facilitative Functions
25. Classification of Markets – On the Basis of Location – Area/Coverage – Time Span – Volume of Transaction – Nature of Transactions – Commodity Transacted – Degree of Competition – Nature of Commodities – Stage of Marketing – Extent of Public Intervention – Type of Population Served – Market Functionaries and

Accrual of Marketing Margins

26. Marketing of Various Channels – Fruits and Vegetables – Flowers – Plantation and Spices
27. Price Spread – Definition – Marketing Costs – Marketing Margins
28. Marketing Efficiency – Definition – Conventional Approach – Shepherd's Approach – Acharya's Approach
29. Market Integration – Definition – Vertical Integration – Horizontal Integration – Conglomerate
30. Market Information – Market News – Market Intelligence – SWOT Analysis
31. Identification of Market Structure – Perfect Competition – Imperfect Competition – Monopoly – Oligopoly – Monopolistic Competition
32. Insurance – Crisis Management – Insurance of crops and protected Cultivation structures

PRACTICALS:

1. Identification of Marketing Channel -I
2. Identification of Marketing Channel -II
3. Calculation of Marketing Cost, Marketing Margins and Price Spread - I
4. Calculation of Marketing Cost, Marketing Margins and Price Spread - II
5. Identification of Market Structure
6. Visit to Different Markets – Vegetable Market – Fruit market – Flower Market
7. Plotting of Demand and Supply Curves and Price determination
8. Problems on Price, Income and Cross Elasticities
9. Problems on Engle's Law of Family Expenditure
10. Forecasting of Horticultural Crops
11. Computation of Marketable and Marketed Surplus
12. Visit to Market Institution – NAFED – Co-operating Marketing Society
13. Visit to Market Institution – CWC – SWC
14. Calculation of Marketing Efficiency
15. Calculation of Indemnity
16. SWOT Analysis of Various Agricultural Marketing Institutions

REFERENCES:

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- Dewett, K.K. and Varma, J.D. 1986 Elementary Economics S. Chand and Co., New Delhi.
- Jhingan, M.L.1990 Advanced Economic Theory Vikas Publishing House, New Delhi.
- H.L. Ahuja, Advanced Economic Theory: Microeconomic Analysis S. Chand and Company Limited in India
- Kotler Phillip and Armstrong. Principles of Marketing. Prentice Hall.
- S.S. Acharya and NL Agarwal, Agricultural Marketing in India Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi.
- Subba Reddy, S, Raghu Ram, P., Sastry, T.V.N. and Bhavani Devi, I. Agricultural Economics Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi.
- https://corporatefinanceinstitute.com/resources/knowledge/strategy/swot-analysis/
- https://pmfby.gov.in/pdf/Revamped%20OGs_Final.pdf
- http://tsmarkfed.com/index.php

ESSC-1.11.3 FUNDAMENTALS OF EXTENSION EDUCATION 2 (1+1)

THEORY:

1. Extension education: meaning, definition, nature, scope, and history of extension
2. Horticulture extension process, principles, and selected programmes of national and international organizations
3. Peoples participation in extension programmes, motivation of farmers, rural youth and voluntary organizations and their impact on overall agricultural development
4. Rural development: meaning, concept, definition, objectives, genesis and pre-independence and post-independence rural development programmes
5. Transfer of Technology programmes (TOT): Lab to Land programme (LLP), national demonstration (ND), Front Line Demonstration (FLD), Krishi Vigyan Kendra (KVK), Agricultural Technology Management Agency (ATMA), Technology Assessment and Refinement Programme (TARP),
6. Communication: meaning, definition, elements, and different models of communication process
7. Monitoring & evaluation of extension programmes: Monitoring- definition & concept Evaluation- definition & types
8. Extension administration: Meaning, concept, principles & functions
9. Extension programme planning: meaning of programme planning & principles
10. Differences between monitoring & evaluation & importance of evaluation in agricultural extension
11. Diffusion and adoption of innovation: Definition & meaning of diffusion & adoption, adoption process: 5 stage & 7 stage models

11. Concept of adoption, over adoption, rate of adoption. Innovation: meaning & attributes of innovation
13. Concept of Participatory Rural Appraisal (PRA), tools, methodology, scope and importance
14. Capacity building of extension personnel and farmers: training meaning, types of training: pre service, in-service, orientation, induction, refresher training
15. Extension teaching methods: Definition, functions, classification according to use & form- individual. Group & mass contact methods
16. Audio visual aids, selection, importance, Media mix, selection & combination of extension teaching methods

PRACTICALS:

1. Visit to DAATCC/KVK centers of Horticultural University
2. Visit to Mahila Mandals, Village panchayat, and voluntary organization involved in horticulture development progrmmes
3. Organization of group discussions
4. Handling and use of Audio-Visual Aids
5. Preparation of extension literature-Leaflet, Booklet, folder, pamphlet
6. Presentation skills - exercise
7. A visit to the village to understand the problems being encountered by the farmers through PRA exercise
8. To study organization and functioning of DRDA and other development departments at district level
9. Understanding PRA techniques and their application in village development planning
10. Exposure to mass media: visit to community radio and television studio for understanding the process of programme production
11. Planning and writing of scripts for radio
12. Planning and writing of scripts for print and electronic media
13. Evaluation of some selected case studies of forestry extension programmes
14. Preparation of village agricultural production plan

15.Visit to villages to know the on-going women development programmes and their functions
16.Visit to NGO and learning from their experience in rural development

REFERENCES:

- Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.
- Dahama, O. P. and Bhatnagar, O.P., 1998, *Education and Communication for Development*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
- Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.
- Muthaiah Manoraharan, P. and Arunachalam, R., *Agricultural Extension*, Himalaya Publishing House (Mumbai).
- Sagar Mondal and Ray, G. L., *Text Book On Rural Development, Entrepreneurship And Communication Skills*, Kalyani Publications.
- Rathore, O. S. *et al.*, 2012, *Handbook of Extension Education*, Agrotech Publishing Academy, Udaipur.
- Ray, G. L., 1991 (1st Edition), *Extension Communication and Management*, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.
- Supe, S. V., 2013 (2nd Edition), *A Text Book of Extension Education*, Agrotech Publishing Academy, Udaipur.
- Van Den Ban, A. W. and Hawkins, H. S., *Agricultural Extension*, S. K .Jain for CBS Publishers & Distributors, New Delhi.
- M Hilaris Indian agriculture and information: Soundari, New century Publications, 2011and communication technology (ICT).

ESSC-1.11.4 COMMUNICATION SKILLS AND PERSONALITY DEVELOPMENT 2(1+1)

THEORY:

1. Communication: Meaning & process of communication. Forms of communication: verbal & non-verbal –meaning
2. Communication skills: Meaning, hard & soft skills – over view
3. Verbal & non- verbal communication: Verbal: oral &written skills Non- verbal communication skills: Concept, meaning, forms & functions, importance of non-verbal communication in communication
4. Listening skill- meaning, concept, types of listening, barriers in listening & Note Taking
5. Oral presentation skills: impromptu presentation & extempore presentation
6. Effective Public Speaking Skills
7. Group discussion: Procedure, principles, purpose, advantages & disadvantages
8. Small group discussion techniques: Panel. Symposium, buzz session, syndicate, conference, seminars, workshop, debate and lecture
9. Writing of technical articles , field diary & lab record, indexing, footnote &bibliographic procedures
10. Personality development : Meaning, definition & overview of personality traits
11. Questioning skills
12. Attitude: Meaning, functions of attitude, developing positive attitude
13. Team building: working in teams
14. Time management: Importance & role in personality development & time management techniques
15. Conflict management: Meaning. Concept, causes of conflict & managing conflicts
16. Stress management : Meaning, definition, management of stress

PRACTICALS:

1. Simulation exercise for non- verbal communication & students feedback
2. Listening & note taking & student feed back
3. Exercise on reading & comprehension & students feedback
4. Exercise on impromptu presentation & students feedback

5&6.Group discussion – Practical exercises

7. Exercise on writing of technical articles& students feedback
8. Identification of personality types- role play& psychological tests & students feedback
9. Attitude-Role play- analysis of attitude & student feedback
10. Working in learners- management games
11. Simulation exercise on time management
12. Simulation exercise on conflict management

13&14. Interview Skills – Mock interviews

15&16. Simulation exercise on creativity.

REFERENCES:

- Fundamentals of extension education and managemant in extension,jalihal K A and Veerabhadraiah,V 2007-concept publising Co,New delhi.
- Theory and practice of journalism-Ahuja B N 1979,Surjith publications,Delhi.
- Soft skills for professional excellence-personality development-Vol I and II,Ratan reddy,B and Supriya Reddy,B.2006,CRTD Publications,Hyderabad.
- PersonalityDevelpoment-Vaikuntam,B.199, kalyani publishers, New Delhi.
- You can win,shiv khera 2002-MacMillan,Publishing company,New Delhi.
- A youngsters Guide To Personality development-Anil kumar S,Poornima S C,Mini K Abraham and jayashree K -2003,New age international publishers,New Delhi-110002.
- Dynamics of entrepreneurial development and management-P.C.Reddy,P.N.Reddy 1999,TATA Mcgraw-Hill Publishing company Ltd.New Delhi.
- Principles of management and Administration-D.Chandra Bose,2008,Preventive-Hall of India PVt Ltd.Delhi

ESSC-1.11.5 INFORMATION AND COMMUNICATION TECHNOLOGY 2(1+1)

THEORY:

1. IT and its importance
2. IT tools, IT enabled services and their impact on society
3. Computer fundamentals: Hardware and Software, Input and output devices
4. Word and character representation
5. Features of machine language, assembly language, high level language and their advantages and disadvantages
6. Principles of programming- Algorithms and Flowcharts
7. Audio-Visual aids- Definition, advantages
8. Classification and choice of A.V aids
9. Cone of experience and criteria for selection and evaluation of A.V aids
10. Video conferencing
11. Communication process- Berlo's model,
12. Feedback and barriers to communication
13. Smartphone apps in agriculture for farm advices, market price, post harvest management etc.
14. Geo-spatial technology for generating valuable Agri-information
15. Decision support system- Concepts, components and application in agriculture
16. Agriculture expert system

PRACTICALS:

1. Internet applications
2. Web browsing
3. Creation and operation of Email account
4. Analysis of data using MS Excel

5&6. Handling of Audio visual aids

7,8&9.Planning, preparation, presentation of posters, charts, overhead transparencies and slides

10. Organization of audio visual programmes

11&12.Introduction of Geospatial Technology for generating valuable information for agriculture

13&14. Hands on decision support system

15&16. Demonstration of Agri-information system

REFERENCES:

- Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. *Fundamentals of Computer Programming and Information Technology*. Kalyani Publishers.
- Harshawardhan P. Bal. 2003. *Perl Programming for Bioinformatics*. Tata McGraw-Hill Education.
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- Rajaraman V & Adabala N. 2015. *Fundamentals of Computers*. PHI.

ESSC – 1.11.6 COMPREHENSION SKILLS IN ENGLISH 1(0+1)

PRACTICAL

1. Exercise on Reading Skills andReading Comprehension
2. Vocabulary and– exercise for TOEFL and Other Competitive Examinations
3. Functional Grammar
4. Subject Verb Agreement
5. Transformation and Synthesis
6. Direct and Indirect Narration
7. Exercise onParagraph Writing
8. Exercise on Précis Writing
9. Report Writing and Proposal Writing - Synopsis Writing
10. The Style: Importance of Professional writing
11. Preparation of Curriculum Vitae and Job Applications
12. Interviews: Kinds – Importance – Process
13. Listening to Short Talks, Lectures and Speeches
14. Phonetics – Stress and Intonation – Conversation – Rate of Speech – Clarity of Voice – Speaking and Listening
15. Mock interviews
16. Group Discussions

REFERENCES:

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- Balasubramaniam T. (1985). Business Communication. Vani Educational Books, New Delhi.
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- Knapp, M.L. & Hall, J.A. (2001). Nonverbal communication in human action. Belmont,CA: Wadsworth.
- Krishna Mohan and Meera Banerjee (1990). Developing Communication Skills. Macmillan India Ltd., New Delhi.
- Krishnaswamy N and Sriraman T. (1995). Current English for Colleges. Macmillan India Ltd., Madras.
- Narayanaswamy VR (1979). Strengthen your Writing. Orient Longman, New Delhi.
- Nichols, J.N. (1980). Using paragraph frames to help remedial high school students withwritten assignment. Journal of Reading, 24, 228-31.
- Raymond B. Fosdick. A Dilemma – A layman looks at Science
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- Sharma RC and Krishna Mohan (1978) Business Correspondence, Tata McGraw-Hill Publication, New Delhi.
- Shaw G. B. You and Your English – Spoken English and Broken English.
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- Wren and Martin, High School English Grammar & Composition, S. Chand and Co.
- Publication.
- http://www.listen.org.

ESSC – 3.11.1 HORTI - BUSINESS MANAGEMENT 2(2+0)

THEORY:

1. Farm Management – Meaning – Definitions – Nature – Characteristics – Scope – Objectives - Relationship with Other Sciences – Farm Management Decisions
2. Economic Principles Applied to Farm Management – Principle of Variable Proportions – Determination of Optimum Input and Optimum Output
3. Principle of Factor Substitution – Principle of Product Substitution
4. Minimum Loss Principle (Cost Principle) – Opportunity Cost Principle
5. Law of Equi-Marginal Returns – Principle of Comparative Advantage – Time Comparison Principle
6. Factor – Product Relationship – Production Function – Three Stages of Production Function
7. Factor – Factor Relationship – Isoquant and Their Characteristics – Marginal Rate of Technical Substitution (MRTS) – Types of Resources – Types of Factor Substitution
8. Iso-Cost Lines – Characteristics – Methods of Determining Least-Cost Combination of Resources – Expansion Path – Isoclines – Ridge Lines
9. Product-Product Relationship – Production Possibility Curve – Marginal Rate of Product Substitution (MRPS) – Types of Enterprise Relationships – Types of Factor Substitution
10. Iso-Revenue Line and Characteristics – Methods of Determining Optimum Combination Of Products – Expansion Path – Ridge Lines
11. Costs Concepts and Curves – Fixed Costs – Variable Costs – Total Costs – Average Variable Costs – Average Fixed Costs – Average Cost – Marginal Costs – Long run and Short run Curves
12. Cost Function – Meaning– Types of Cost Function – Costs of Cultivation and Production
13. Economies of Scale – Returns to Scale – Constant Returns to Scale – Increasing Returns to Scale – Decreasing Returns to Scale – Difference between returns to scale and law of variable proportions
14. Breakeven Analysis – Decision Making Under Risk and Uncertainty – Nature and Sources of Risks – Production and Technical Risks – Price or Marketing Risk – Financial Risk – Methods of Reducing Risk
15. Types of Farming – Specialization – Diversification – Mixed Farming – Dry Farming – Ranching – Factors Influencing Types of Farming
16. System Of Farming – Peasant Farming – Co-operative Farming – Capitalistic Farming, Collective Farming – State Farming
17. Management and its Functions – Planning – Meaning – Steps and Methods of Planning – Types of Plan – Characteristics of Effective Plan
18. Organization – Form of Business Organization – Individual Enterprise – Partnership – Joint Stock Company – Co-operative Organization – State or Public Enterprise
19. Organizational Principles – Division of Work – Authority and Responsibility – Discipline – Unity of Command – Unity of Direction – Subordination of Individual Interest – Remuneration – The Degree of Centralization – Scalar Chain – Order – Equity – Stability of Tenure Of Personnel – Initiative – Esprit De Corps
20. Direction – Guiding – Leading – Motivating – Supervising
21. Co-Ordination – Meaning – Control – Types and Methods Of Controlling – Evaluation – Control System and Devices
22. Budgeting as a Tool Of Planning and Control – Record Keeping as a Tool of Control
23. Functional Areas of Management – Operation Management – Physical Facilities – Implementing the Plan – Scheduling the Work – Controlling Production in Terms of Quality And Quantity
24. Material Management – Types of Inventories – Inventory Cost– Economic Order Quantity (EOQ)
25. Managing the Inventories – Inventory Management in India – Commonly Used

Inventory Management Tools – ABC Analysis – JIT Analysis

26. Personnel Management – Recruitment – Selection and Training– Job Specialization
27. Marketing Management – Definition – Planning the Market Programmes – Market Mix and Four P's
28. Financial Management – Goal – Capital Budgeting – Financial Statements – Balance Sheet – Profit and Loss Statement – Cash Flow Statement
29. Financial Ratios – Liquidity Ratios – Leverage Ratios – Coverage Ratios – Turnover Ratios – Profitability Ratios
30. Project Management – Meaning – Definition – Project Cycle – Identification – Formulation – Appraisal – Monitoring – Evaluation
31. Project Appraisal and Evaluation Techniques/measures – Undiscounted Measures – Payback Period – Proceeds Per Rupee of Outlay
32. Discounted Measures – Net Present Value (NPV) – Benefit-Cost Ratio (BCR) – Internal Rate of Return (IRR) – Net Benefit Investment Ratio (N/K Ratio) – Sensitivity Analysis

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3. Grittier Price, J. (1989), Economics Analysis of Agricultural Projects, John Hopkins University Press, London.
4. Johl, S.S. and Kapoor, T.R. (1973), Fundamentals of Farm Business Management, Kalyani Publishers, Ludhiana.
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6. Kahlon, A.S. and Karam Singh (1992), Economics of Farm Management, Allied Publishers, New Delhi.
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13. Prasanna Chandra. Projects. Tata McGraw-Hill Publication, New Delhi
14. Prasanna Channdra. Projects – Planning, Analysis, Selection, Financing, Implementation and Review. Tata McGraw-Hill Publication, New Delhi
15. P. Subba Rao. Human Resource Management. Himalaya Publishing House.
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17. Sankhayan, P.L. (1988), Introduction to the Economics of Agricultural Production, Prentice Hall of India Private Limited, New Delhi.
18. Subba Reddy, S, Raghu Ram, P., Sastry, T.V.N. and Bhavani Devi, I. Agricultural Economics Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi.
19. N. Chapman Stephen, Arnold J. R. Tony, Gatewood Ann K. and M. Clive Lloyd. Introduction to Material Management. 8th Edition Pearson.

ESSC-3.11.2 ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS MANAGEMENT 2(1+1)

THEORY:

1. Concept of entrepreneur, entrepreneurship, functions of entrepreneur
2. Entrepreneurial characteristics, Distinction between an entrepreneur and a manager, Horti-entrepreneurship- concept, need and scope
3. Assessing overall business environment in Indian economy, globalization, implications of social, political and economic systems on entrepreneurship
4. Entrepreneurship development programmes (EDPs) - objectives, phases, problems of EDPs, Criteria for assessment or evaluation of EDPs
5. Generation, incubation and commercialization of business ideas
6. Role of entrepreneurship in economic development, Motivation and entrepreneurship development, Managing an enterprise
7. Importance of planning, budgeting, monitoring, evaluation and follow up in running an enterprise
8. Researching / managing competition- ways to define possible competitors, competitive information, SWOT analysis-concept, meaning and advantages
9. Venture capital- concept, aims, features, financing steps sources, criteria to provide venture capital finance, Export & Import policies relevant to agriculture sector
10. Forms of business-contract farming, joint venture and public private partnership
11. An overview of horticultural input industry in India; fertilizer, pesticide, seed and farm machinery industry
12. Over view of Indian horticultural processing industry
13. Social responsibility and business ethics
14. Project- meaning, importance, components &preparation
15. Government schemes and incentives for promotion of entrepreneurship and government policy on small and medium enterprises
16. Supply chain management- meaning, advantages, stages, process, drivers and scope of horti-supply chain management, Women entrepreneurship-concept, problems and development of women entrepreneurs.

PRACTICALS:

1. Field visit to successful enterprise - study of characteristics of successful entrepreneurs
2. Visit to a public private enterprise
3. SWOT analysis of selected enterprise
4. Preparation of field diary and maintaining lab record
5. Preparation of indexing, footnote, bibliographic procedures
6. Exercise on Reading, comprehension of general, technical articles, summarizing and abstracting
7. Exercise on writing of technical articles& students feedback
8. Conducting market survey to the demand for product, preparing advertisements for popularization of products
9. Exercise on news writing, preparing project proposals, individual, and group presentations
10. Exercise on evaluation of sheet, dyadic communication, telephone conversation, speaking and listening skills
11. Simulation exercise on time management
12. Simulation exercise on conflict management
13. Interview Skills – Mock interviews
14. Presentations of PPTs on various aspects of entrepreneurship development and

write up

15. Simulation exercise on creativity
16. Exercise on general and group meeting and participation in seminars and conferences

REFERENCES:

- Benjamin MC Donald P. 1985, *Investment Projects in Agriculture- Principles and Case studies*. Longman Group Limited. Essex. UK.
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- Hopkins J A and Baker C B Danville, *Financial Management in Agriculture*, 6th ed Barry P J, IL Interstate Publishers.
- Kotler Philip and Armstrong, *Principles of Marketing*. Prentice-Hall.
- Pandey U. K., *An Introduction to Agricultural Finance.*
- Sagar Mondal and G. L. Ray, *Text Book on Rural Development, Entrepreneurship and Communication Skills*, Kalyani Publications.
- Somani, L. L., *Extension Education and Communication*, Agrotech, Publishing Academy, Udaipur.
- Dr. A.K. Singh, 2009.Entrepreneurship Development and Management. Lakshmi Publications Ltd.,
- S. Anil Kumar, S.C Poornima, M.K. Abhraham and K. Jayashree, 2008; Entrepreneurship Development. New Age International Publishers

DEPARTMENT OF HORTICULTURAL ENGINEERING AND ENVIRONMENTAL SCIENCE

HEES–1.12.1 ENVIRONMENTAL SCIENCE AND DISASTER MANAGEMENT **3(2+1)**

THEORY:

1. Environmental Studies: Scope and importance.
2. Natural Resources: Renewable and non-renewable resources Natural resources and associated problems.
3 Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
4 Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
5 Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
6 Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
7 Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies.
8. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources.Equitable use of resources for sustainable lifestyles.
9. Ecosystems: Concept, Structure, function, Producers, consumers, decomposers, Energy flow, ecological succession, food chains, food webs, ecological pyramids.
10. Biodiversity:Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India.
11. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.
12. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity.
13. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity
14. Environmental Pollution: definition, cause, effects and control measures of Air pollution, Water pollution, Soil pollution.
15. Environmental Pollution: definition, cause, effects and control measures of Marine pollution, Noise pollution, Thermal pollution,Nuclear hazards.
16. Role of an individual in prevention of pollution. Pollution case studies
17. Solid Waste Management: causes, effects and control measures of urban and industrial wastes.
18. Social Issues and the Environment from Unsustainable to Sustainable development, Urban problems related to energy.

19. Water conservation, rain water harvesting, watershed management.
20. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust dies.
21. Wasteland reclamation. Consumerism and waste products.
22. Environment Protection Act. Air (Prevention and Control of Pollution) Act.Water (Prevention and control of Pollution) Act.Wildlife Protection Act.Forest Conservation Act. Issues involved in enforcement of environmental legislation.
23. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme.
24. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare.Role of Information Technology in Environment and human health.

Disaster Management:

25. Natural Disasters and nature of natural disasters, their types and effects.
26. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.
27. 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.
28. Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction.
29. Concept of disaster management, national disaster management framework; financial arrangements
30. Role of NGOs, community-based organizations and media.
31. Central, state, district and local administration involves disaster management.
32. Armed forces in disaster response; Disaster response; Police and other organizations.

PRACTICALS:

1. Case Studies and Field work of different Environment issues.
2. Visit to a local area to document environmental assets river/forest/grassland/hill/mountain
3. Visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

4&5. Expected impact of climate change on agricultural production and water resources and Mitigation Strategies,

6. Economics of climate change.
7. Disaster Management introduction,
8 Natural and Manmade Disaster Studies,

9&10. Informatics for Disaster Management, Quantitative Techniques for Disaster Management

11&12 Environmental Impact Assessment (EIA) and. Disaster Management Policy

13. Environmental Modelling.
14. Visit to recycling units of biodegradable waste material

15&16. Visit to local polluted sites – observations and remedial measures

REFERENCES:

- Bharucha Erach. 2005. Text Book of Environmental Studies for Undergraduate Courses. University Grants Commission, University Press, Hyderabad.
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- Chary Manohar and Jaya Ram Reddy. 2004. Principles of Environmental Studies. BS Publishers, Hyderabad.
- Kaul S N, Ashuthosh Gautam. 2002. Water and Waste Water Analysis. Days Publishing House, Delhi.
- Gupta P K. 2004. Methods in Environmental Analysis – Water. Soil and Air. Agro bios, Jodhpur.
- Climate change.1995: Adaptation and mitigation of climate change-Scientific Technical Analysis Cambridge University Press, Cambridge.
- Sharma, R.K. & Sharma, G. 2005. Natural Disaster. APH Publishing Corporation, New Delhi.
- Husain Majid. 2013. Environment and Ecology: Biodiversity, Climate Change and Disaster Management

HEES - 1.12.2 FARM POWER AND MACHINERY 2(1+1)
THEORY:

1. Concept and Importance of farm mechanization, Farm power - Current Status (in Telangana and India) and different sources of farm power
2. Basic concepts of various forms of energy, power, unit and dimensions of force, energy and power, calculations with realistic examples
3. IC Engines: Basic principles of operation of compression ignition and spark ignition engines, two stroke and four stroke engines, IC Engine terminology
4. Cooling system- Purpose of cooling system, air cooling system and water cooling system, open jacket method, forced circulation method, and pressurized cooling method
5. Fuel system –Properties of Fuel, Fuel supply system in Spark ignition and Diesel engine, Precausions in handling Fuel system.
6. Lubrication system- Purpose of lubrication, types of lubricants, engine lubricating system- forced feed system, splash lubrication system, combination of splash and forced feed system
7. Power transmission system of a tractor - functions of clutch, gear box, differential unit and final drive, Ignition system – spark ignition, storage battery, care and maintenance of battery, Ignition by heat of compression.
8. Broad understanding of performance and efficiency of tractors, power tillers, their types and uses
9. Electric motors: Types, construction and performance comparison, Types of electric motors used for different Farm Operation System, Induction motor, selection of a Electric Motor.
10. Tillage: Objectives, Method of ploughing, Primary tillage implements: construction and function of indigenous ploughs, improved indigenous ploughs,mould board ploughs, disc and rotary ploughs rotavator, chisel plough, subsoil.
11. Secondary tillage implements: construction and function of harrows, Cultivators, levelers, ridger and bund formers
12. Sowing and transplanting equipment: seed drills planters, calibration of seed drill, potato planters, seedling transplantors.
13. Introduction of plant protection equipments
14. Grafting, pruning and training tools and equipment
15 Implements for intercultural operation: Sweep. Junior hoe, weeders, long handle weeders, etc.
16. Crop harvesting equipments: potato diggers, fruit pluckers, tapioca puller and hoists

PRACTICALS:

1. Calculation on force, energy and power, cost of operation of tractor

2 &3.IC engines – showing the components of dismantled engines and motors

4. Study of Primary tillage implements
5. Study of Secondary tillage implements
6. Hitching, adjustments and operation of implements with Tractor

7. Seed drill calibration
8. Study of tools used for plant propagation, training and pruning
9. Study of Plant protection equipment, calculation of dilution ratio and operation
10. Equipment for making pits in the soil for planting fruit plants, equipments used for soiland water conservation.
11. Visit to tractor service centre
12. Visit to implements manufacturing unit
13. Harvesting equipments-potato diggers, fruit pluckers, tapioca puller and hoists
14, 15 &16 Learning tractor and power tiller driving.

REFERENCES:

- T. P. Ojhaand A.M.Michael. 2005. *Principles of Agricultural Engineering* (Volume - 1), Jain Brothers
- Manoj Kumar Ghoshal and Dhirendra Kumar Das. 2008. *Farm Power,*Kalyani Publishers.
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- Roth / Field. 1992. *Introduction to Agricultural Engineering - Problem Solving Approaches*, 2nd. Edition. CBS publishers & distributors Pvt. Ltd.
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- M.M. Pandey & Others. 2012. *Handbook of Agricultural Engineering*. ICAR publication
- JagadishwarSahay.1992. *Elements of Agricultural Engineering.* Agro Book Agency, Patna.
- MichalAMandOjhaTP.1993.*VolI. Principles of Agricultural Engineering* .JainBrothers, NewDelhi.
- Kepner RARoy Bainer and Barger BL. 1978. *Principles of Farm Machinery*. CBS Publisher and Distributors, Delhi.
- JainS C. 2003.*Farm Machinery-Anapproach.* Stand and Publishers and Distributors, NewDelhi
- Nakra,C.P.1986. *Farm Machinery and Equipment.* Dhanpat Rai and Sons, NewDelhi
- Klenin, N.I.Popov, I.F.and Sakun,V.A.1985. *Agricultural Machines*. Amerind publishing Co.Pvt.Ltd.,New Delhi.

HEES.3.12.2 PRECISION FARMING AND PROTECTED CULTIVATION 3(2+1)
THEORY:

1. Precision farming -Definition, scope, concept and components of precision farming. Introduction to precision Horticulture.
2. Introduction to Global Positioning System (GPS)
3. Introduction to remote sensing, Remote Sensing Application in precision farming, Sensors used in Precision Farming.
4. Introduction to GIS.
5. Application of GIS in Precision Farming.
6. Site Specific Management practice, uniform Rate Technology, variable rate Technology basics.
7. Variable rate technology – Soil & Water spatial variability
8. Variable rate technology – nutrient spatial variability, Crop spatial variability.
9. Automation in precision farming.
10. Site specific input application, preparation of soil fertility maps, grid based soil sampling.
11. Yield mapping – yield monitoring basics.
12. Image classification, spatial & temporal analysis
13. Introduction to green houses - definition, greenhouse effect, advantages of green houses.
14. Brief description of types of green houses - greenhouses based on shape, utility, construction, covering materials and cost, shade nets.
15. Material of construction for traditional and Low Cost Greenhouse.

16&17. Plant response to greenhouse environments - light, temperature, relative humidity, ventilation and carbon dioxide and environmental requirement of horticulture crops inside green houses.

18. Equipment required for controlling green house environment
19. Planning of green house facility - site selection and orientation, structural design and covering materials.
20. Materials for construction of green houses - wood, galvanized iron, glass, polyethylene film, poly vinyl chloride film, Tefzel T2 film, fiberglass reinforced plastic rigid panel and acrylic and polycarbonate rigid panel.
21. Design criteria of green house for cooling and heating purpose.
22. Problems / constraints of greenhouse cultivation and future strategies.
23. Irrigation system used in greenhouses-rules of watering, hand watering, perimeter watering, overhead sprinklers, boom watering and drip irrigation.
24. Hot air greenhouse heating systems, Passive solar green house.
25. Green House Drying.
26 Selection of crops for green house cultivation (Tomato, Capsicum, Cucumber) Leafy Vegetables
27. Cost estimation and economic analysis of protected cultivation
28. Types of Growing Media, Soil Culture.
29. Type of soil required, drainage, flooding and leaching,

30. Soil pasteurization in peat moss and mixtures.
31. Rock wool and other inert media used in protected cultivation.
32. Nutrient Film Technique/ Hydroponics.

PRACTICALS:

1. GPS Position determination.
2. GPS receiver to interphase computer.
3. Introduction to GIS, Co – ordinate systems.
4. Component of GIS, map scales, spatial and temporal analysis
5. Image classification.
6. Economics of precision Horticulture technologies.
7. Study of different types of greenhouses based on shape, utilityconstruction and cladding materials
8. Calculation of air rate exchange in an active summer cooling system
9. Calculation of air rate exchange in an active winter cooling system.
10. Estimation of drying rate of agricultural products inside green house;
11. Testing of soil and water to study its suitability for growing crops in greenhouses;
12. The study of fertigation requirements for greenhouses crops and estimation of E.C. in the fertigation solution;
13. The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization / sterilization;

14&15. Visit to commercial greenhouses;

16. Economics of protected cultivation

REFERENCES:

- Balraj Singh. 2006. *Protected cultivation of vegetable crops*. Kalyani Publishers, Ludhiana.
- Brahma Singh, 2014.*Advances in Protected Cultivation*. New India Publishing Agency. New Delhi.
- Reddy P. Parvatha, 2003. *Protected Cultivation*. Springer Publications. USA.
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- Jitendra Singh, 2015.*Precision Farming in Horticulture*. New India Publishing Agency. New Delhi.
- Prasad S. 2005.*Greenhouse Management for Horticultural Crops*. Agrobios. Jodhpur.
- Jitendra Singh, S.K. Jain, L.K. Dashora, B.S. Cundawat.2013. *Precision forming in Horticulture*. New India Publishing Agency, New Delhi.
- T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008. *Management of Horticultural crops*. New India Publishing Agency, New Delhi.
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- Pant V Nelson. 1991.*Green House Operation and Management*. Bali Publ.,
- De Mess M. N. Fundamental of Geographic Information System. John Willy and Sons, New York .
- Kuhar, John. E. 1977. The precision farmimg guide for agriculturalist. Lori J. Dhabalt, USA.
- Lille Sand, T and Kaiffer, R. Remote Sensing and Image Interpretation, John Willy and Sons, London.

HEES - 3.12.3 REMOTE SENSING AND GIS APPLICATIONS 2(1+1)

THEORY:

1. Basic components of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources;
2. Electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface;
3 Major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water;
4. Spectral signatures; different types of sensors and platforms; contrast ratio and possible causes of low contrast;
5. Aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap;
6. Stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation- interpretation elements;
7. Photogrammetry- measurements on a single vertical aerial photograph measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography;
8 Satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions;
9 Analysis of digital data- image restoration; image enhancement; information extraction.
10 Analysis of digital image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; microwave remote sensing.
11. GIS and its basic components,
12. Different sources of spatial data, basic spatial entities, major components of spatial data,
13. Basic classes of map projections and their properties.
14. Methods of data input into GIS.
15. Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS,
16. Application of remote sensing and GIS for the management of land and water resources.

PRACTICALS:

1&2. Familiarization with remote sensing and GIS hardware.
2&3. Use of software for image interpretation.
4,5&6. Interpretation of aerial photographs and satellite imagery.
7,8&9. Basic GIS operations such as image display.
10,11,12&13. Study of various features of GIS software package; scanning, digitization of maps and data editing; data base query and map algebra.
14,15&16. GIS supported case studies in water resources management.

REFERENCES:

- Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
- Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
- George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
- Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
- Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
- Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.
- Sahu, K.C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
- Shultz, G.A. and E.T. Engman. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York

Student READY – Rural Entrepreneurship Awareness Development Yojana(VII and VIII semesters)

***Semester – VII – RHWEP / Semester – VIII - HELP**

****Semester – VII – ELP (two modules) + Semester VIII – RHWEP**

S.N	Title of the Course	Credit Hours
1	Student READY – RHWEP in Villages / Industries / Tours	0+20
2	Horticultural Experiential Learning Programme	0+20
	Module – I (0+10)	
	Module – II (0+10)	
	Total	**40(0+40)**
	Grand Total	**184(85+99)**

S.No.	Name of the Modules	Course number	Course credits
1	Commercial Horticulture	HELP - 401	0+10
2	Protected cultivation of high value Horticulture crops	HELP – 402	0+10
3	Processing of fruits and vegetables for value addition	HELP – 403	0+10
4	Floriculture and landscape architecture	HELP – 404	0+10
5	Bio-inputs: Bio-fertilizers and bio-pesticides	HELP – 405	0+10
6	Mass multiplication of plant and molecules through tissue culture	HELP – 406	0+10
7	Mushroom culture	HELP – 407	0+10
8	Bee keeping	HELP – 408	0+10
9	Organic farming	HELP – 409	0+10
10	Seed production of Horticultural crops	HELP – 410	0+10
11	Agri waste Management(Composting)	HELP- 411	0+10
	Student should register any two modules	**20(0+20)**	

*Batch (50%) of students of IV year will register RHWE in VII Semester and HELP (2 modules) in VIII Semester

**Another (remaining 50%) batch of students of IV year will register HELP (2 modules) in VII Semester and RHWE in VIII Semester.