Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior

TITLE

Professional Ethics, Gender, Human Values, Environment and Sustainability and other value framework enshrined in Sustainable Development Goals and National Education Policy – 2020

- Program-1 B.Sc. (Hons) Agriculture
- Program-2 B.Sc. (Hons) Horticulture
- Program-(3-15) M.Sc. Agriculture & Horticulture
- Program-16 Ph.D. Program

- **Font in blue denotes relevance to Gender Equity**
- **Relevance to Human Values Professional Ethics highlighted in Yellow**
- **Relevance to Environment & Sustainability highlighted in Green**

PROGRAMME-1

B.Sc. (Hons.)

Agriculture

5. AGR – 222 (Farming Systems and Sustainable Agriculture)

Credit Hours: 1 (1+0)

Topics in Theory:

S. No.	Topics
1.	Farming System-scope, importance, and concept
2.	Types and systems of farming system and factors affecting types of farming
3.	Farming system components and their maintenance,
4.	Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation
5.	Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system
6.	Sustainable agriculture-problems and its impact on agriculture indicators of sustainability, adaptation and mitigation,
7.	Conservation agriculture strategies in agriculture
8.	LEIA (Low external input agriculture), LEISA, HEIA (High external input agriculture)
9.	Integrated farming system-historical background, objectives & characteristics, components of IFS and its advantages,
10.	Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques,
11.	Resource cycling and flow of energy in different farming system,
12.	Farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmer's field.

Suggested Readings:

- Panda, S.C. (2004). Cropping Systems and Farming Systems, Agrobios (India), Jodhpur.
- Sharma, Arun K. 2002. A Handbook of Organic Farming, Agrobios (India) Ltd., Jodhpur
- Balasubramaniyan, P. and Palaniappan, S.P.2016. Principles and Practices of Agronomy (II Edition), Agrobios (India), Jodhpur.
- Shukla, Rajeev K. 2004. Sustainable Agriculture, Surbhee Publications, Jaipur
- Palaniappan, S.P.1985. Cropping Systems in the Tropics: Principles and Management, Wiley Easter Ltd. and TNAU, Coimbatore.
- Reddy S. R. 2016. Principles of Agronomy (5th edition), Kalyani Publishers, Ludhiana.
- गौतम, आर.सी. एवं सिंह, पंजाब. 1997. टिकाउ खेती, भारतीय कृषि अनुसन्धान परिषद, नई दिल्ली.

6. AGR – 223 (Introductory Agro-meteorology & Climate Change)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Meaning and scope of agricultural meteorology
2.	Earth's atmosphere- its composition, extent and structure, Atmospheric weather

	variables; Atmospheric pressure, its variation with height, Wind, types of wind, daily and seasonal variation of wind speed
3.	Cyclone, anticyclone, land breeze and sea breeze
4.	Nature and properties of solar radiation, solar constant, depletion of solar radiation, Short wave, long wave and thermal radiation, net radiation, albedo
5.	Atmospheric temperature, temperature inversion, lapse rate, Daily and seasonal variations of temperature, vertical profile of temperature,
6.	Energy balance of earth; Atmospheric humidity, concept of saturation, vapour pressure,
7.	Process of condensation, formation of dew, fog, mist, frost, cloud
8.	Precipitation- process, types such as rain, snow, sleet, and hail
9.	Cloud formation and classification; Artificial rainmaking, Monsoon-mechanism and importance in Indian agriculture
10.	Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave
11.	Agriculture and weather relations; Modifications of crop microclimate, climatic normal for crop and livestock production
12.	Weather forecasting- types of weather forecast and their uses Climate change, climatic variability, global warming, Causes of Climate Change and its impact on regional and national Agriculture.

Topics in Practical:

S. No.	Topics
1.	Visit of Agro-meteorological Observatory, site selection of observatory, exposure of instruments and weather data recording.
2.	Measurement of total, shortwave and long wave radiation, and its estimation using Planck's intensity law.
3.	Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS.
4.	Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis.
5.	Measurement of soil temperature and computation of soil heat flux.
6.	Determination of vapor pressure and relative humidity.
7.	Determination of dew point temperature.
8.	Measurement of atmospheric pressure and analysis of atmospheric conditions.
9.	Measurement of wind speed and wind direction, preparation of wind rose.
10.	Measurement, tabulation and analysis of rain.
11.	Measurement of open pan evaporation and evapo-transpiration.
12.	Computation of PET and AET.

Suggested Readings:

- Sacheti, A.K. 1985. Agricultural Meteorological Instructional Cum Practical Manual (Ed.)

NCERT Publication, New Delhi.

- Lal, D.S. 2005 Climatology, Sharda Pustak Bhawan, Allahabad.
- Varshneya, M.C. and Balakrishna, Pillai, 2003. Text book of Agricultural Meteorology. ICAR, New-Delhi.
- Sahu, D.D., 2007. Agrometeorology and Remote sensing: Principles and Practices , Agrobios (India) , Jodhpur.
- Murithy, K. and Radha, V. 1995. Practical Manual on Agricultural Meteorology , Kalyani Publishers, New-Delhi
- Ghadekar, S.R. (2002 fourth edition). Practical meteorology, Agromet publishers Nagpur (M.S.)
- धीमान, आर.पी.एस. कृशि मौसम एवं जलवायु विज्ञान, रामा पब्लिगि हाउस, मेरठ
- राजपूत, ओ.पी. एवं सिंह राजवीर, (2008). कृशि मौसम विज्ञान एवं जलवायु विज्ञान के सिद्धांत, कुाल पब्लिकेान, वाराणसी

7. AGR – 311 [Practical Crop Production-I (Kharif Crops)]

Credit Hours: 2 (0+2)

Topics in Theory:

S. No.	Topics
1.	Introduction of the course, crop planning and allotment of field
2.	Field preparation, application of manures and fertilizers
3.	Selection of crop and varieties, seed treatment and sowing
4.	Sowing of crops.
5.	Observation of germination
6.	Thinning and gap filling
7.	Intercultural operations-hoeing and weeding
8.	Water management- application of irrigation water and demonstrating methods of irrigation
9.	Top dressing of fertilizer (urea).
10.	Insect and pest management (control)- application of insecticides
11.	Disease management (control)- application of fungicides
12.	Harvesting
13.	Threshing, winnowing and storage
14.	Marketing of produce

Suggested Readings:

- Yawalkar, K.S.; Agarwal, J.P. and Bokde, S. 2008. Manures and Fertilizers (10th edition), Agri-Horticultural Publishing House, Nagpur.
- Balasubramaniyan, P. and Palaniappan, S.P. 2016. Principles and Practices of Agronomy Agrobios (India), Jodhpur.
- Reddy, S. R., 2016. Principles of Agronomy (5th edition), Kalyani Publishers, Ludhiana.
- Singh, S.S. and Singh, Rajesh. 2015. Principles and Practices of Agronomy (5th Re-set), Kalyani Publishers, New Delhi, Kalyani Publishers, Ludhiana.

8. AGR-312 Geo-informatics and Nano-technology for Precision Farming

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Precision agriculture: concepts and techniques; their issues and concernsfor Indian agriculture;
2.	Geo-informatics definition, concepts, tool and techniques; their use in Precision Agriculture
3.	Crop discrimination and Yield monitoring, soil mapping;
4.	Fertilizer recommendation using geospatial technologies; Spatial data and their management in GIS;
5.	Remote sensing concepts and application in agriculture;
6.	Image processing and interpretation;
7.	Global positioning system (GPS), components and its functions;
8.	Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs
9.	STCR approach for precision agriculture;
10.	Nanotechnology, definition, concepts and techniques,
11.	Brief introduction about nanoscale effects,
12.	Nano-particles, nano-pesticides, nano-fertilizers, nano-sensors,
13.	Use of nanotechnology in seed and water for scaling-up farm productivity
14.	Use of nanotechnology in fertilizer and plant protection for scaling-up farm productivity

Topics in Practical:

S. No.	Topics
1.	Introduction to GIS software, spatial data creation and editing.
2.	Introduction to image processing software. Visual and digital interpretation of remote sensing images.
3.	Generation of spectral profiles of different objects.
4.	Supervised and unsupervised classification and acreage estimation.
5.	Multispectral remote sensing for soil mapping.
6.	Creation of thematic layers of soil fertility based on GIS.
7.	Creation of productivity and management zones
8.	Fertilizers recommendations based of VRT and STCR techniques.
9.	Crop stress (biotic/abiotic) monitoring using geospatial technology.
10.	Use of GPS for agricultural survey.
11.	Formulation, characterization and applications of nanoparticles in agriculture

12.	Projects formulation and execution related to precision farming

Suggested Readings:

- Krishna, K.K. 2013. Precision Farming: Soil Fertility and Productivity Aspects. Apple Academic Press
- Srivastava, G.S. 2014. An Introduction to Geoinformatics. McGrew Hill Education (India) Pvt. Ltd. , New Delhi
- Gupta, R.K. and Subhash Chander. 2008. Principles of Geoinformatics. Jain Brothers, New Delhi.
- Choudhary, S. 2011. Applied Nanotechnology in Agriculture. Arise Publishers & Distributors
- Sekhon, B.S. 2014. Nanotechnology in agri-food production: an overview. Nanotechnology, Science and Applications **7**:31-532.

9. AGR – 321 [Practical Crop Production-II (Rabi Crops)]

Credit Hours: 2 (0+2)

Topics in Theory:

S. No.	Topics
1.	Allotment of land and field preparation
2.	Sowing methods, selection of crops, varieties and seed treatment
3.	Preparation of seed bed and sowing of crops
4.	Thinning and gap filling
5.	Fertilizer application including top dressing of fertilizers
6.	Intercultural operations- hoeing and weeding
7.	Application of moisture conservation practices
8.	Insect and pest management /control – application of insecticides.
9.	Disease management/control –application of fungicides
10.	Harvesting of the crops
11.	Threshing, winnowing and storage
12.	Marketing of produce
13.	Preparation of balance sheet including cost of cultivation and net return per student as well as team of a group of students.

Suggested Readings:

- Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 2008. Manures and Fertilizers (10th edition), Agri-Horticultural Publishing House, Nagpur.
- Balasubramaniyan, P. and Palaniappan, S.P.2016. Principles and Practices of Agronomy (2nd edition), Agrobios (India), Jodhpur.
- Reddy, S. R. 2016. Principles of Agronomy (5th edition), Kalyani Publishers, Ludhiana.
- Singh, S.S. and Singh, Rajesh. 2015. Principles and Practices of Agronomy (5th Re-set), Kalyani Publishers, New Delhi, Kalyani Publishers, Ludhiana.

10. AGR – 322 (Principles of Organic Farming)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Organic farming, principles and its scope in India;
2.	Initiatives taken by Government (Central/State), NGOs and other organizations for promotion of organic agriculture;
3.	Organic ecosystem and their concepts;
4.	Organic nutrient resources and its fortification;
5.	Restrictions to nutrient use in organic farming;
6.	Choice of crops and varieties in organic farming;
7.	Fundamentals of insect, pest, disease mgt
8.	Weed management under organic mode of production;
9.	Operational structure of NPOP
10.	Certification process and standards of organic farming;
11.	Processing, levelling, economic considerations and viability,
12.	Marketing and export potential of organic products

Topics in Practical:

S. No.	Topics
1.	Visit of organic farms to study the various components and their utilization;
2.	Preparation of enrich compost,
3.	Vermicompost,
4.	Bio-fertilizers/bio-inoculants and their quality analysis;
5.	Indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management;
6.	Cost of organic production system;
7.	Post-harvest management;
8.	Quality aspect, grading, packaging and handling.

Suggested Readings:

- Dhama, A.K. 2014. Organic Farming for Sustainable Agriculture (2nd edition), Agrobios (India), Jodhpur.
- Sharma, Arun K. 2013. A Handbook of Organic Farming, Agrobios (India), Jodhpur
- Palaniappan, S.P. and Anandurai, K.1999. Organic Farming – Theory and Practice. Scientific Pub. Jodhpur
- Thapa, U and Tripathy, P. 2006. Organic Farming in India, Problems and prospects, Agrtech, Publising Academy, Udaipur.

➢ शर्मा, अरूण के. 2015. जैविक खेती – नई दिशाए, एग्रोबायोस (इण्डिया), जोधपुर

11. AGR – 323 (Rainfed Agriculture and Watershed Management)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Rainfed agriculture- definition, history and its importance in India with particular to references Rajasthan
2.	Problems of dryland agriculture related to climate, soil, technological and socio-economic conditions
3.	Soil and water conservation techniques, Drought: types,
4.	Effect of water deficit on physio-morphological characteristics of the plants,
5.	Use of antitranspirants-their kind, mode of action and effect on crop yield.
6.	Crop adaptation and mitigation to drought;
7.	Water harvesting: importance, its techniques,
8.	Efficient utilization of water through soil and crop management practices,
9.	Water harvesting techniques in dry farming areas
10.	Watershed management- concept, definition, objectives and principles
11.	Integrated watershed management for drylands, a study of model watershed area
12.	Management of crops in rainfed areas,
13.	Contingent crop planning for aberrant weather conditions,
14.	Alternate cropping and land use strategies for dryland agriculture

Topics in Practical:

S. No.	Topics
1.	Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons.
2.	Studies on cropping pattern of different rainfed areas in the country and demarcation of rainfed area on map of India.
3.	Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops.
4.	Critical analysis of rainfall and estimation of moisture index and aridity index and possible drought period in the country
5.	Field demonstration on construction of water harvesting structures, effective rainfall and its calculation.
6.	Studies on cultural practices for mitigating moisture stress.
7.	Spray of antitranspirants on dryland crops and their effect on crops
8.	Characterization and delineation of model watershed
9.	Field demonstration on soil & moisture conservation measures

10.	Crops and cropping systems for drylands
11.	Acquiring skill in tillage methods for *in-situ* moisture conservation
12.	Mulching and its effects on soil moistures conservation
13.	Seed soaking, seed treatment with chemicals for sowing in dryland areas
14.	Visit to rainfed research station/watershed**.**

Suggested Readings:

- Jayanthi, C. and Kalpana, R. 2016. Dryland Agriculture, Kalyani Publishers, Ludhiana.
- Reddy, S.R. and Reddy, G. Prabhakara. 2015. Dryland Agriculture, Kalyani Publishers, Ludhiana.
- Murthy, J. V. S. 1994. Watershed Management, Wiley Eastern Limited. New Age International Limited, New Delhi.
- Dhruva Narayan, V.V. Singh, P.P., Bhardwaj, S.P., U. Sharma, Sikha, A.K., Vital, K.P.R. and Das, S.K. 1987. Watershed Management for Drought Mitigation, ICAR, New Delhi.
- Singh, R.P., Sharma, S., Padmanabhan, N.V. , Das, S.K. and Mishra, P.K. 1990.A Field Manual on Watershed Management, ICAR (CRIDA), Hyderabad.
- Singh, P.K. 2000. Watershed Management (Design & Practices), e-media Publication, Udaipur, India.
- Singh, R.P. 1995, Sustainable Development of Dryland Agriculture in India. Scientific Publishers, Jodhpur.

12. AGR – 324 (Weed Management)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Introduction to weeds
2.	Characteristics of weeds
3.	Harmful and beneficial effects of weeds on ecosystem
4.	Classification of weeds
5.	Reproduction and dissemination of weeds
6.	Dormancy in weeds and its types
7.	Crop-weed competition
8.	Principles of weed management- an introduction
9.	Physical and cultural methods of weed control
10.	Chemical and biological methods of weed control
11.	Herbicide classification
12.	Herbicide active ingredient and formulations
13.	Herbicide application - types and techniques
14.	Introduction to mode of action of herbicides

15.	Herbicidal selectivity to plants
16.	Fate of herbicides
17.	Concept of adjuvant- surfactant, stabilizing agents, stickers, activators and compatibility agents and solvents
18.	Bio-herbicides and their application in agriculture.
19.	Concept of herbicide mixture and utility in agriculture.
20.	Herbicide compatibility with agro-chemicals and their application.
21.	Allelopathy and its application for weed management.
22.	Integrated weed management - An introduction
23.	Integration of herbicides with non chemical methods of weed management.
24.	Weed management in rice, wheat, barley, maize, sorghum and bajra
25.	Weed management in oil seeds and pulses – groundnut, soybean, mustard, gram, lentil, mungbean and urdbean
26.	Aquatic weeds and their management

Topics in Practical:

S. No.	Topics
1.	Identification of weeds and techniques of weed preservation
2.	Collection of common *kharif/rabi* weeds and their preservation
3.	Collection of common perennial weeds and their preservation
4.	Biology of important weeds.
5.	Study of herbicide formulations and mixture of herbicide.
6.	Herbicide and agro-chemicals study.
7.	Shift of weed flora study in long term experiments.
8.	Study of methods of herbicide application,
9.	To become familiar with herbicide spray equipments.
10.	Calibration of herbicide spray equipments
11.	Calculation on herbicidal requirement for field crops and Aquatic situations
12.	Application of pre plant , pre-emergence and post emergence herbicides in the field.
13.	Calculations of weed control efficiency and weed index.
14.	Farm visit to problem areas of weeds

Suggested Readings:

- Saraswat, V.N., Bhan, V.M. and Yaduraju, N.T. 2003. Weed Management , ICAR, New-Delhi.
- Gupta, O.P. 2015. Weed Management: Principles and Practices (2nd Ed.), Agribios (India), Jodhpur.
- Gupta, O.P. 2016. Modern Weed Management , Agribios (India), Jodhpur
- Das, T.K. 2008. Weed Science : Basics and Applications , Jain Brothers, New-Delhi.

Department – Agricultural Engineering

17. AEG – 121 (Soil and Water Conservation Engineering)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Introduction to Soil and Water Conservation causes of soil erosion.
2.	Definition and agents of soil erosion.
3.	Water erosion and its forms -raindrop, sheet, rill and gully erosion.
4.	Gully classification and control measures.
5.	Soil loss estimation by universal Soil Loss Equation.
6.	Principles of water erosion control: Introduction to contouring, strip cropping. Contour bund.
7.	Graded bund and bench terracing.
8.	Grassed waterways and their design.
9.	Water harvesting and its techniques.
10.	Wind erosion- mechanics of wind erosion, types of soil movement.
11.	Principles of wind erosion control and its control measures.

Topics in Practical:

S. No.	Topics
1.	General status of soil conservation in India and Madhya Pradesh.
2.	Calculation of soil erosion index.
3.	Estimation of soil loss.
4.	Measurement of soil loss.
5.	Preparation of contour maps.
6.	Design of grassed waterways.
7.	Design of contour bunds.
8.	Design of graded bunds.
9.	Design of bench terracing system.
10.	Problem on wind erosion.

Suggested Readings:

- Water harvesting and recycling: Indian experience. Sharma and Sikka. Central Soil Water Conservation Research Institute, Dehradun.
- Land and Water Management Engineering. 1982. Murthy V.V.N. Kalyani Publishers, New Delhi.
- Irrigation: Theory and Practices.2012. Michael A.M. Vikas Publishing House Pvt. Ltd., New Delhi.
- Principles of Agricultural. Engineering. Vol. II. 2012. Michael A.M. and T.P. Ojha. Jain Brothers, New Delhi.

10.	Familiarization with seed-cum-fertilizer drills their seed metering mechanism.
11.	Calibration of seed drill and numerical based on it.
12.	Study of planters and transplanters.
13.	Familiarization with different types of sprayers and dusters.
14.	Familiarization with different inter-cultivation equipment.
15.	Familiarization with harvesting and threshing machinery.

Suggested Readings:

- Principles of Agricultural Engineering. Vol. I. 2012. Michael, A.M. and T.P. Ojha. Jain Brothers, Jodhpur.
- Farm Tractors, Maintenance and Repair.1989. Rai and Jain. Tata Mc Graw Hill Publ. New Delhi.
- Elements of Farm Machinery.1989. Srivastava, A.C. Oxford IBH Publ. Company, New Delhi.
- Elements of Agricultural Engineering, Vol. I & III. 1989. Singhal, O.P. Suraj Prakashan, Allahabad.
- Element of Agricultural Engineering. 1990. Sahay, Jagdishwar. Agro. Book Agency, New Chitragupta Nagar, Patna.

19. AEG – 221 (Renewable Energy and Green Technology)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Classification of energy sources, contribution of these sources in agricultural sector.
2.	Familiarization with biomass utilization for bio fuel production and their application.
3.	Familiarization with different types of biogas plants-fixed dome and floating drum type biogas plants.
4.	Biogas production techniques and various uses of biogas.
5.	Biomass gasification and familiarization with different types of gasifiers-.cross draft, updraft and down draft gasifiers.
6.	Bio alcohol, biodiesel and bio-oil production and their utilization as bio energy resource
7.	Introduction of solar energy, their collection and application
8.	Familiarization with solar energy gadgets: solar cooker, solar water heater
9.	Application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system and their application
10.	Introduction of wind energy and their application.

Topics in Practical:

S. No.	Topics
1.	To Study of fixed dome and floating drum type biogas plants.
2.	To Study of cross draft, updraft and down draft gasifiers.

3.	To study the production process of biodiesel.
4.	To study briquetting machine.
5.	To study the production process of bio-fuels.
6.	To study solar photovoltaic system: solar light, solar pumping, and solar fencing.
7.	To study solar cooker,
8.	To study solar drying system.
9.	To study solar distillation and solar pond.

Suggested Readings:

- Navinikrat Urja Srot (Hindi) Rathore NS. Himanshu Publications.
- G.D. Rai. Non-Conventional Energy Sources, Khanna Publishers, New Delhi.
- N. S. Rathore. A.K. Kurchania, N.L. Panwar. (2007). Non-Conventional Energy Sources, Himanshu Publications.
- N.S. Rathore. A. K. Kurchania, N.L. Panwar. (2007). Renewable Energy, Theory and Practice, Himanshu Publications.
- K.C. Khandelwal. & S.S. Mandi. (1990). Biogas Technology.

20. AEG – 321 (Protected Cultivation and Secondary Agriculture)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Introduction to greenhouse technology, types of green houses and Plant response to Greenhouse environment.
2.	Planning and design of greenhouses.
3.	Design criteria of green house for cooling and heating purposes.
4.	Greenhouse equipments, materials of construction for traditional and low-cost green houses.
5.	Irrigation systems used in green houses.
6.	Passive solar green house and hot air greenhouse heating systems, greenhouse drying.
7.	Cost estimation and economic analysis of green house.
8.	Important engineering properties such as physical, thermal, aero & hydrodynamic of cereals, pulses and oilseed. Application of these in PHT equipment design and operation.
9.	Drying and dehydration: Moisture measurement, EMC, drying theory, various drying methods.
10.	Commercial grain dryer (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, re-circulatory dryer and solar dryer).
11.	Material handling equipment: conveyers and elevators, their working principle and selection.

Department – Entomology

21. ENT – 121 (Fundamental of Entomology)

Credit Hours: 4 (3+1)

Topics in Theory:

S. No.	Topics
1.	Definition and importance of entomology. History of entomology in India. Factors of insect's abundance.
2.	Phylum Arthropoda- classification up to classes with examples and their relationship with class Insecta
3.	Structure of insect body segmentation – head, thorax & abdomen. Structure & functions of insect cuticle and moulting
4.	Structure & modifications of antennae and mouth-parts.
5.	Structure & functions of legs and wings
6.	Wing venation and wing coupling apparatus
7.	Structure & functions of male and female genital organs
8.	Structure & functions of digestive and circulatory systems.
9.	Structure & functions of excretory and respiratory systems.
10.	Structure & functions of endocrine and reproductive systems. Types of reproduction.
11.	Structure & functions of nervous system. Major sensory organs like simple and compound eyes and chemoreceptors.
12.	Types of metamorphosis, diapause, larvae and pupae.
13.	Definition & importance of insect ecology. Components of environment.
14.	Effect of abiotic factors [temperature, moisture, humidity, rainfall, light, atmospheric pressure and air current].
15.	Effect of biotic factors [food competition, natural & environmental resistance]. Concept of balance of nature
16.	Definitions of biotic potential & causes of outbreak of pests in agro-ecosystem.
17.	Categories of pests; pest surveillance and pest forecasting.
18.	Definition & importance of IPM. Tools of IPM like host plant resistance, cultural and legislative methods [Insecticide Act 1968].
19.	Mechanical, physical and biological methods [parasites, predators and transgenic plant pathogens like bacteria, fungi and viruses].
20.	Chemical control – importance, hazards & limitations. Classification of insecticides.
21.	Toxicity of insecticides. Formulations of chemical insecticides.
22.	Recent methods – repellents, antifeedants, hormones, attractants, gamma radiation and genetic control [definitions with examples].
23.	Practices, scope and constraints of IPM.
24.	Application techniques of spray fluids, phytotoxicity. Precautions in using chemical insecticides. Symptoms of poisoning, first-aid and antidotes.
25.	Systematics & taxonomy – definitions, importance, history and development. Binomial

	nomenclature. Definitions of biotype, sub-species, species, genus, family and order.
26.	Modern scheme of insect classification up to order [According to Gillott, 2005].
27.	Main characters of insect orders of agricultural importance with names of important families including examples – Odonata, Blattaria [Blattidae], Isoptera [Termitidae, Mantodea [Mantidae].
28.	Order Orthoptera [Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae]. Order Thysanoptera [Thripidae].
29.	Order Hemiptera [Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophopidae, Aleurodidae, Pseudococcidae].
30.	Order Neuroptera [Chrysopidae]. Order Coleoptera [Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae.
31.	Order Diptera [Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae].
32.	Order Lepidoptera [Pieridae, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bobmycidae].
33.	Order Hymenoptera [Tenthridinidae, Apidae, Trichogrammatidae, Braconidae, Clacididae].

Topics in Practical:

S. No.	Topics
1.	Methods of collection & preservation of insects including immature stages.
2.	External features of grasshopper.
3.	Types of antennae, mouth-parts and legs.
4.	Types of wings & wing coupling apparatus.
5.	Types of larvae & pupae.
6.	Dissection of digestive system of grasshopper.
7.	Dissection of reproductive system of male & female grasshopper.
8.	Study of major characters of order Orthoptera and Isoptera with the help of grasshopper and Termite, respectively.
9.	Study of major characters of order Blattaria with the help of sample of cockroach.
10.	Study of major characters of order Hemiptera with the help of sample of green stink bug.
11.	Study of major characters of order Lepidoptera with the help of samples any moth and butterfly.
12.	Study of major characters of order Coleoptera with the help of samples of any weevil and beetle.
13.	Study of major characters of order Diptera with the help of samples of House fly
14.	Sampling techniques for estimation of insect pest population and damage.

Suggested Readings:

- Ambrose, D.P. [2004]. The Insects: Structure, function and biodiversity. Kalyani Publishers,

Suggested Readings:

- Ambrose, D.P. [2007]. The Insects: Beneficial and Harmful Aspects. Kalyani Publishers, Ludhiana.
- Atwal, A.S. and Dhaliwal, G.S. [2002]. Agricultural Pests of South Asia and Their Management. Kalyani Publishers, Ludhiana.
- Awasthi, V.B. [2007]. Agricultural Insect Pests and Their Control. Scientific Publishers (India), Jodhpur.
- Dhaliwal, G.S. [2008]. An Outline of Entomology. Kalyani Publishers, Ludhiana.
- Hill, D.S. [1993]. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, Cambridge.
- Kachhwaha, N. [2011]. Principles of entomology basic and applied. AGROBIOS, Jodhpur.
- Mathur, Y.K. and Upadhyay, K.D. [2012]. A textbook of entomology [7th Edition]. Aman Publishing House, Meerut.
- Sharma, Sandeep and Choudhary, Arun [2007]. Storage Pests Management. Mahamaya Publishers, New Delhi.
- Sharma, Sandeep [2013]. Instructional manual on Pests of Field Crops. RVSKVV Publication No. 29/2013.
- Shrivastava, K.P. and Dhaliwal, G.S. [2011]. A Textbook of Applied Entomology Vol. II (Third Edition). Kalyani Publishers, Ludhiana.

23. ENT – 321 (Management of Beneficial Insects)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Importance of beneficial insects. Beekeeping, various species of honey bees, bee biology and different castes of bees in bee colony.
2.	Bee keeping equipments, bee hives, commercial method of bee rearing.
3.	Seasonal management of bee colony, management for pollination, honey production, swarm control, absconding, summer and rainy season, before and after migration of bee colony and queen management.
4.	Bee pasturage, bee pollinating plants, bee foraging and communication skill in honey bees.
5.	Natural enemies of bees and their management.
6.	Importance of sericulture, types of silk worms, host plants and type of silk produced by them.
7.	Voltinism in silk worm, factors induce voltinism, biology of silk worm.
8.	Varieties of mulberry, mulberry cultivation, methods of harvesting and preservation of mulberry leaves.
9.	Rearing equipments and rearing techniques of silk worm, mounting, harvesting of cocoon and reeling.
10.	Natural enemies of silk worm and their management.
11.	Importance of lac culture, uses of lac, species of lac insects and their morphology.

	Biology and host plants of lac insects.
12.	Production techniques of lac, types of lac, i.e., seed lac, button lac and shellac flacks. Natural enemies of lac insect and their management.
13.	Identification of major insect parasitoids and predators commonly being used in biological control.
14.	Mass multiplication techniques of major parasitoids and predators.

Topics in Practical:

S. No.	Topics
1.	Identification of various bee species and castes. Identification of natural enemies of honey bees.
2.	Handling of bee keeping equipments, bee foraging and communication.
3.	Practical knowledge of seasonal management of bee colony.
4.	Types of silk worms and its biology.
5.	Familiarization with mulberry varieties, cultivation [Moriculture], harvesting of leaves and preservation.
6.	Identification of lac insect and their host plants.
7.	Identification of various insect pollinators, weed killers and scavangers.
8.	Visit to research and training centers of apiculture, sericulture, lac culture and biological control.
9.	Identification of technique for

Suggested Readings:

- Atwal, A.S. [2000]. Essentials of bee keeping and pollination. Kalyani Publishers, Ludhiyana.
- Devid, B.V. and Ananthakrishnan, T.N. [2004]. General and Applied Entomology. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Gillot, Cedric [2005]. Entomology [Third Edition]. Springer, Dordrecht, Netherlands.

Department – Genetics and Plant Breeding

28. GPB – 121 (Fundamentals of Genetics)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Pre and Post Mendelian concepts of heredity
2.	Mendelian principles of heredity
3.	Cell division – mitosis & Meiosis
4.	Probability and Chi-square
5.	Dominance relationships and gene interaction
6.	Epistatic gene interactions with examples (complementary, supplementary, duplicate gene interactions)
7.	Epistatic gene interactions with examples (masking, inhibitory, polymeric and additive gene interactions)
8.	Pleiotropism, pseudoalleles, Multiple alleles and Blood group genetics
9.	Sex determination
10.	Sex linkage & Sex limited, sex influenced and sex linked traits
11.	Linkage and its estimation
12.	Crossing over : introduction & mechanisms
13.	Chromosome mapping
14.	Structural changes in chromosome
15.	Numerical changes in chromosome Use of haploids, dihaploids and doubled haploids in Genetics
16.	Mutation: introduction, characteristics & classification
17.	Mutagenic agents: physical and chemical mutagens
18.	Induction of mutation, Methods of inducing mutation & CIB technique
19.	Qualitative & Quantitative traits, Polygenes and continuous variations
20.	Multiple factor hypothesis
21.	Cytoplasmic inheritance
22.	Genetic disorders
23.	Nature, structure and types of genetic material
24.	Proof for DNA as genetic material
25.	Replication of genetic material
26.	Genetic code & Protein synthesis
27.	Transcription mechanism of genetic material
28.	Translational mechanism of genetic material
29.	Gene concept: Gene structure and function
30.	Gene regulation, operon concept, Lac and Trp operons

Topics in Practical:

S. No.	Topics
1.	Study of microscope: parts and types
2.	Study of cell structure
3.	Experiments on monohybrid, test cross and back cross
4.	Experiments on dihybrid, test cross and back cross
5.	Experiments on trihybrid, test cross and back cross
6.	Experiments on epistatic interactions including test cross and back cross
7.	Stains and their preparation
8.	Fixatives and their preparation
9.	Practice on mitotic & Meiotic cell division
10.	Experiments on probability
11.	Experiments on Chi-square test
12.	Determination of linkage and cross over analysis (through two point test cross and three point test cross data)
13.	Study on sex linked inheritance in Drosophila
14.	Study of models on DNA and RNA structure

Suggested Readings:

- Gupta P.K.2004. *Cytology, Genetics and Evolution*. Rastogi Publications, Meerut. (Hindi Edition)
- Klug, W.W. and Cummings, M.R.2005.*Concepts of Genetics.* Pearson Education (Singapore) Pvt. Ltd., Indian Branch, Pratap Ganj, New Delhi.
- Singh, B.D. 2001.*Genetics.* Kalyani
- Strickberger, M.W.2001.*Genetics.* Prentice Hall of India. Pvt. Ltd., New Delhi.

29. GPB – 211 (Fundamentals of Plant Breeding)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Plant breeding: concept, nature, objectives and role of plant breeding
2.	Historical development of plant breeding
3.	Genetics in relation to plant breeding, Major achievements and future prospects
4.	Domestication, Acclimatization, introduction, Centre of origin/diversity
5.	Modes of reproduction and pollination, apomixes
6.	Self – incompatibility
7.	Male sterility- genetic consequences
8.	Component of Genetic variation; Heritability and genetic advance

9.	Genetic basis of self- pollinated crops and Cross-Pollinated Crops
10.	Breeding methods in self- pollinated crops- mass and pure line selection
11.	Hybridization techniques
12.	Handling of segregating population (pedigree, bulk and back cross method)
13.	Multiline concept
14.	Concepts of population genetics and Hardy-Weinberg Law
15.	Population improvement and modes of selection Ear to row method, Modified Ear to Row, recurrent selection schemes
16.	Heterosis and inbreeding depression
17.	Development of inbred lines and hybrids
18.	Composite and synthetic varieties
19.	Breeding methods in asexually propagated crops
20.	Clonal selection and hybridization
21.	Wide hybridization and pre-breeding
22.	Polyploidy in relation to plant breeding
23.	Mutation breeding- methods and uses
24.	Breeding for important biotic stresses
25.	Breeding for important abiotic stresses
26.	Biotechnological tools-DNA markers
27.	Marker assisted selection
28.	Participatory plant breeding
29.	Intellectual Property Rights and Patenting
30.	Plant Breeders and & Farmer's Rights

Topics in Practical:

S. No.	Topics
1.	Plant Breeder's kit
2.	Study of germplasm of various crops
3.	Study of floral structure of self-pollinated crops
4.	Study of floral structure of cross-pollinated crops
5.	Emasculation and hybridization techniques in self-pollinated crops
6.	Emasculation and hybridization techniques in cross pollinated crops
7.	Consequences of inbreeding on genetic structure of resulting populations
8.	Study of male sterility system
9.	Handling of segregating populations
10.	Methods of calculating mean, range, variance, standard deviation, heritability
11.	Designs used in plant breeding experiment
12.	Analysis of Randomized Block Design and components of genetic variance

13.	To work out the mode of pollination in a given crop and extent of natural out crossing
14.	Prediction of performance of double cross hybrids

Suggested Readings:

- Allard, R.W. 2000.Principles of Plant Breeding. John Willey & Sons, New York.
- Chahel, G.S. and S.S. Ghosal.2002.Principles and Procedures of Plant Breeding, Biotechnological and Conventional Approaches. Narosa Publishing House, New Delhi.
- Singh, B.D. 2005. Plant Breeding. Kalyani Publishing House, New Delhi.
- Singh, P. 2001.Essentials of Plant Breeding-Principles and Methods. Kalyani Publishing House, New Delhi.

30. GPB – 221 (Principles of Seed Technology)

Credit Hours: 3 (1+2)

Topics in Theory:

S. No.	Topics
1.	Seed and seed technology: introduction, definition and importance
2.	Deterioration causes of crop varieties and their control; Maintenance of genetic purity during seed production
3.	Seed quality; Definition, Characters of good quality seed, different classes of seed
4.	Foundation and certified seed production of important cereals & fodder crops.
5.	Foundation and certified seed production of important pulses
6.	Foundation and certified seed production of important oil seed crop
7.	Foundation and certified seed production of important vegetables
8.	Seed certification, phases of certification, procedure for seed certification, field inspection
9.	Seed Act and Seed Act enforcement. Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983
10.	Varietal Identification through Grow Out Test and Electrophoresis, Molecular and Biochemical test
11.	GM crops and Detection of genetically modified crops, Transgene contamination in non-GM crops
12.	Organic seed production techniques
13.	Seed drying, processing and their steps, seed testing for quality assessment, seed treatment, its importance, method of application and seed packing
14.	Seed storage; general principles, stages and factors affecting seed longevity during storage. Measures for pest and disease control during storage
15.	Seed marketing: structure and organization, sales generation activities, promotional media. Factors affecting seed marketing, Role of WTO and OECD in seed marketing

Topics in Practical:

S. No.	Topics
1.	Seed production in wheat including seed standards
2.	Seed production in rice including seed standards
3.	Seed production in Maize including seed standards
4.	Seed production in Sorghum & Bajra including seed standards
5.	Seed production in Urd, Mung and Cowpea including seed standards
6.	Seed production in Pigeonpea including seed standards
7.	Seed production in Lentil ,Gram & Field pea including seed standards
8.	Seed production in Soybean including seed standards
9.	Seed production in Rapeseed and Mustard including seed standards
10.	Seed production in Groundnut and Sesame including seed standards
11.	Seed production in vegetable crops (Potato, Brinjal, tomato and chilli) including seed standards
12.	Seed production in Seed spices (fenugreek, , cumin & coriander) including seed standards
13.	Seed sampling methods
14.	Physical purity test
15.	Germination test
16.	Viability test
17.	Seed and seedling vigour test
18.	Genetic purity test: Grow out test
19.	Electrophoresis
20.	Seed certification: Procedure
21.	Field inspection and Preparation of field inspection report
22.	Visit to seed production farms
23.	Visit to seed testing laboratories
24.	Visit to seed processing plant

Suggested Readings:

- Agarwal, R.L.1991.Seed Technology. Oxford & IBH Publishing Co. Delhi
- Agarwal, P.K. 1999. Seed Technology. ICAR, New Delhi.
- Subir Sen and Nabinanda Ghosh.1999. Seed Science and Technology. Kalyani Publishers. New Delhi.
- Dhirendra Khare and Mohan S. Bhale.2000. Seed Technology. Scientific Publishers (India), Jodhpur.
- Maloo, S.R., Intodia, S.K. and Pratap Singh.2008. Beej Pradyogiki. Agrotech Publishing Academy.
- A.K. Joshi and B.D. Singh.2005.Seed Technology. Kalyani Publishers, New Delhi.

➢ Arya, P.S. 2001. Vegetable Breeding and Seed Production. Kalyani Pub., Ludhiana

31. GPB – 222 (Commercial Plant Breeding)

Credit Hours: 3 (1+2)

Topics in Theory:

S. No.	Topics
1.	Types of crops and modes of plant reproduction
2.	Line development and maintenance breeding in self- and cross-pollinated crops (A/B/R and two-line system) for development of hybrids and seed Production
3.	Genetic purity test of commercial hybrids
4.	Advances in hybrid seed production of maize, rice, sorghum, pearl
5.	Millet
6.	Advances in hybrid seed production of castor, sunflower
7.	Advances in hybrid seed production of cotton, pigeon pea, brassica
8.	Quality seed production of vegetable crops under open and protected Environment
9.	Alternative strategies for the development of the line and cultivars: haploid inducer
10.	Tissue culture techniques
11.	Biotechnological tools
12.	IPR issues in commercial plant breeding
13.	DUS testing and registration of varieties under PPV & FR Act
14.	Variety testing, release and notification systems in India
15.	Types of seeds, Principles and techniques of seed production
16.	Quality testing in self- and cross-pollinated crops

Topics in Practical:

S. No.	Topics
1.	Floral biology in self-pollinated species
2.	Floral biology in cross pollinated species
3.	Selfing and crossing techniques
4.	Techniques of seed production in self- and cross-pollinated crops using A/B/R and two-line system
5.	Learning techniques in hybrid seed production using male-sterility in field crops
6.	Understanding the difficulties in hybrid seed production
7.	Tools and techniques for optimizing hybrid seed production
8.	Concept of line its multiplication and purification in hybrid seed Production
9.	Role of pollinators in hybrid seed production
10.	Hybrid seed production techniques in sorghum & Pearl millet
11.	Hybrid seed production techniques in maize

12.	Hybrid seed production techniques in rice
13.	Hybrid seed production techniques in rapeseed-mustard
14.	Hybrid seed production techniques in sunflower
15.	Hybrid seed production techniques in pigeon pea
16.	Hybrid seed production techniques in cotton
17.	Hybrid seed production techniques in vegetable crops
18.	Sampling and analytical procedures for purity testing and detection of spurious seed
19.	Seed drying
20.	Seed storage structure in quality seed management
21.	Screening techniques during seed processing viz., grading and Packaging
22.	Visit to public private seed production units
23.	Visit to public private seed processing plants

Suggested Readings:

- Chopra, V.L. 2000. *Breeding of Field Crops* (Edt.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Mandal, AK., P.K. Ganguli and S.P. Banerjee. 1991. *Advances in Plant Breeding*. Vol. I and II. CBS Publishers and Distributors, New Delhi.
- Manjit S. Kang 2004. *Crop Improvement: Challenges in the Twenty-First Century* (Edt). International Book Distributing Co. Lucknow.
- Poehlman, J.M. 1987. *Breeding of Field Crops*. AVI Publishing Co. INC, East Port, Conneacticut, USA.

32. GPB – 311 [Crop Improvement – I (Kharif crops)]

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Centers of origin, distribution of species, wild relatives in different Kharif cereals & pulses
2.	Centers of origin, distribution of species, wild relatives in different Kharif oilseeds, fibres, fodders and cash crops, vegetable and horticultural crops
3.	Plant genetic resources, its utilization and conservation of Kharif crops
4.	Study of genetics of qualitative and quantitative characters; Important concepts of breeding Kharif self-pollinated,
5.	Study of genetics of qualitative and quantitative characters; Important concepts of breeding Kharif cross pollinated
6.	Important concepts of breeding Kharif vegetatively propagated crops
7.	Major breeding objectives and procedures including conventional and modern innovative approaches for development of Kharif hybrids and varieties for yield, adaptability & stability,

8.	Important concepts of breeding for Abiotic and biotic stress tolerance of Kharif crops
9.	Important concepts of breeding for Quality (physical, chemical, nutritional) of Kharif crops
10.	Ideotype concept of Kharif crops
11.	Climate resilient Kharif crop varieties for future.

Topics in Practical:

S. No.	Topics
1.	Floral Biology, Emasculation and hybridization techniques in rice, maize
2.	Floral Biology, Emasculation and hybridization techniques in sorghum and bajra
3.	Floral Biology, Emasculation and hybridization techniques in urd, mung, cowpea, pigeonpea
4.	Floral Biology, Emasculation and hybridization techniques in, soybean, sesame
5.	Floral Biology, Emasculation and hybridization techniques in and groundnut and cotton
6.	Maintenance breeding of different kharif crops
7.	Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods
8.	Study of field techniques for seed production and hybrid seeds production in *Kharif* crops
9.	Estimation of heterosis, inbreeding depression and heritability of Kharif crops
10.	Layout of field experiments of Kharif crops
11.	Study of quality characters of Kharif crops
12.	Donor parents for different characters of Kharif crops
13.	Visit to seed production plots of Kharif crops
14.	Visit to AICRP plots of different field of Kharif crops

Suggested Readings:

- Chopra, V.L. 2000. *Breeding of Field Crops* (Edt.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Chaddha. K.L. and Rajendra Gupta. 1995. Vol. II Medicinal and Aromatic Plant. Malhotra Publishing House, New Delhi.
- Mandal, A. K., P.K. Ganguli and S.P. Banerjee. 1991. *Advances in Plant Breeding.* Vol. I and II. CBS Publishers and Distributors, New Delhi.
- Manjit S. Kang 2004. *Crop Improvement: Challenges in the Twenty-First Century* (Edt). International Book Distributing Co. Lucknow.
- Poehlman, J.M. 1987. *Breeding of Field Crops.* AVI Publishing Co. INC, East Port, Conneacticut, USA.

33. GPB – 312 (Intellectual Property Rights)

Credit Hours: 1 (1+0)

Topics in Theory:

S. No.	Topics
1.	Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO
2.	Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc
3.	Types of Intellectual Property and legislations covering IPR in India:- Patents, Copyrights, Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets
4.	Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement
5.	Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database
6.	Origin and history including a brief introduction to UPOV for protection of plant varieties
7.	Protection of plant varieties under UPOV and PPV & FR Act of India, Plant breeders' rights, Registration of plant varieties under PPV&FR Act 2001
8.	Breeders, researcher and farmers rights. Traditional knowledge-meaning and rights of TK holders
9.	Convention on Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA)
10.	Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing

Suggested Readings:

- B D Singh: Principles of plant breeding, Kalyani publication, New Delhi
- Phundan Singh: IPR and plant breeders right , Kalyani publication, New Delhi
- Phundan Singh and Rajeev Singh : IPR and plant breeders right at a glance , Kalyani publication, New Delhi

34. GPB – 321 [Crop Improvement – II (Rabi Crops)]

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Centers of origin, distribution of species, wild relatives in different Rabi cereals & pulses;
2.	Centers of origin, distribution of species, wild relatives in different Rabi oilseeds, fibres, fodders and cash crops, vegetable and horticultural crops
3.	Plant genetic resources, its utilization and conservation, Rabi crops
4.	Study of genetics of qualitative and quantitative characters; Important concepts of breeding Rabi self-pollinated crops

5.	Study of genetics of qualitative and quantitative characters; Important concepts of breeding Rabi cross pollinated crops
6.	Important concepts of breeding Rabi vegetatively propagated crops
7.	Major breeding objectives and procedures including conventional and modern innovative approaches for development of Rabi hybrids and varieties for yield, adaptability stability
8.	Important concepts of breeding for Abiotic and biotic stress tolerance Rabi crops
9.	Important concepts of breeding for Quality (physical, chemical, nutritional) of Rabi crops
10.	Ideotype concept of Rabi crops
11.	Climate resilient of Rabi crop varieties for future

Topics in Practical:

S. No.	Topics
1.	Floral Biology, Emasculation and hybridization techniques in wheat, & barley
2.	Floral Biology, Emasculation and hybridization techniques in chickpea, lentil, field pea
3.	Floral Biology, Emasculation and hybridization techniques in rapeseed mustard
4.	Floral Biology, Emasculation and hybridization techniques in sunflower, potato
5.	Floral Biology, Emasculation and hybridization techniques in berseem, sugarcane
6.	Maintenance breeding of different rabi crops
7.	Handling of germplasm and segregating populations of Rabi crops by different methods like pedigree, bulk and single seed decent methods
8.	Study of field techniques for seed production and hybrid seeds production in *rabi* crops
9.	Estimation of heterosis, inbreeding depression and heritability of Rabi crops
10.	Layout of field experiments of Rabi crops
11.	Study of quality characters of Rabi crops
12.	Donor parents for different characters of Rabi crops
13.	Visit to seed production plots of Rabi crops
14.	Visit to AICRP plots of different field of Rabi crops

Suggested Readings:

- Chopra, V.L. 2000. *Breeding of Field Crops* (Edt.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Chaddha. K.L. and Rajendra Gupta. 1995. *Advances in Horticulture* Vol. II *Medicinal and Aromatic Plants*. Malhotra Publishing House, New Delhi.
- Mandal, AK., P.K. Ganguli and S.P. Banerjee. 1991. *Advances in Plant Breeding* Vol. I and II. CBS Publishers and Distributors, New Delhi.

Department – Plant Pathology

43. PPT – 121 (Fundamentals of Plant Pathology)

Credit Hours: 4 (3+1)

Topics in Theory:

S. No.	Topics
1.	Introduction: Importance of plant diseases, scope and objectives of Plant Pathology
2.	History of Plant Pathology with special reference to Indian work
3.	Terms and concepts in Plant Pathology
4.	Pathogenesis. causes / factors affecting disease development: disease triangle and tetrahedron
5.	Classification of plant diseases
6.	Important plant pathogenic organisms
7.	Different groups of fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas
8.	Different groups of viruses, viroids, algae and protozoa
9.	Phanerogamic parasites and nematodes with examples of diseases caused by them
10.	Diseases and symptoms due to abiotic causes
11.	Fungi :general characters, definition, somatic structures types of fungal thalli, fungal tissues, modifications of thallus
12.	Reproduction in fungi (asexual and sexual).
13.	Nomenclature, binomial system of nomenclature, rules of nomenclature, classification of fungi
14.	Key to divisions , sub-divisions, orders and classes of fungi
15.	Bacteria and mollicutes: general morphological characters, basic methods of classification and reproduction
16.	Viruses: nature, structure, replication and transmission
17.	Study of phanerogamic plant parasites
18.	Nematodes: general morphology and reproduction, Nematode classification
19.	Symptoms and nature of damage caused by plant parasitic nematodes (Heterodera, Meloidogyne, Anguina, Radopholus etc.)
20.	Growth and reproduction of plant pathogens
21.	Liberation / dispersal and survival of plant pathogens
22.	Types of parasitism and variability in plant pathogens, Pathogenesis
23.	Role of enzymes, toxins and growth regulators in disease development
24.	Defense mechanism in plants
25.	Epidemiology: Factors affecting disease development.
26.	Principles and methods of plant disease management
27.	Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

Topics in Practical:

S. No.	Topics
1.	Acquaintance with various laboratory equipments and microscopy
2.	Collection and preservation of disease preparation
3.	Preparation of media, isolation and Koch's postulates
4.	General study of different structures of fungi
5.	Study of symptoms of various plant diseases
6.	Study of representative fungal genera.
7.	Transmission of plant viruses.
8.	Study of morphological features and identification of plant parasitic nematodes.
9.	Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting.
10.	Staining and identification of plant pathogenic bacteria.
11.	Study of phanerogamic plant parasites.

Suggested Readings:

- Agrios, G.N. (2005). Plant Pathology. 5th Edn. Academic Press, New York, USA.
- Bhale, U, Mishra M. ,Kumar, S. and Gupta, OM (2015). Laboratory Manual on Plant
- Pathology, A S AP Publisher.
- Bilgrami, K.S. and Dube, H.C. (1990). A Text book of Modern Plant Pathology, Vikas Publishing House Pvt. Ltd, India; New Ed edition.
- Kamat, M.N. (1967). Introductory Plant Pathology, 3rdEds revised, Prakash Publisher,
- Jaipur.
- Malhrotra, R.S. (2003). Plant Pathology, Tata McGraw-Hill Education,
- Nene, Y.L. and Thapliyal, P. L. (1987). Fungicides in Plant Disease Control, 2ndeds.
- Oxford & IBH Publishing, New Delhi.
- Pathak, V.N. (1972). Essentials of Plant Pathology, Prakash publisher, Jaipur.
- Sathe, T.V. (2011). Agrochemicals and Pest Management, Daya Publishing House.
- Sharma, C.S. (2013). Plant Pathology, Published by Agrotech Press.
- Sharma, P.D. (2013). Plant Pathology, Rastogi Publications, Meerut.
- Sharma, R. (2012). PlantVirus, ABD publisher.
- Singh, R.S. (1990). Plant Diseases. 9th Eds. Oxford & IBH Publishing Company.

2.	Microscope- parts, principles of microscopy, resolving power and numerical aperture
3.	Methods of sterilization.
4.	Nutritional media and their preparations
5.	Enumeration of microbial population in soil- bacteria, fungi, actinomycetes
6.	Methods of isolation and purification of microbial cultures.
7.	Isolation of Rhizobium from legume root nodule
8.	Isolation of Azotobacter from soil
9.	Isolation of Azospirillum from roots
10.	Isolation of BGA
11.	Staining and microscopic examination of microbes

Suggested Readings:

- Rangaswami and Bhagyaraj :Agricultural Microbiology
- N.S. Subbarao : Soil Microbiology
- N. Mukherjee and T. Ghosh :Agricultural Microbiology
- L.L. Somani, S.C. Bhandari S.N. Saxena : Biofertilizers
- M. Alexender : Introduction to soil Microbiology
- P. Tauro, K.K. Kapoor and K.S. Yadav :An Introduction to Microbiology

52. EVS – 211 (Environmental Studies and Disaster Management)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Multidisciplinary nature of environmental studies, Definition, scope and importance
2.	Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
3.	Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
4.	Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
5.	Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.
6.	Land resources: 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.
7.	Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs

8.	Ecological pyramids: Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
9.	Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.
10.	Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. 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.
11.	Environmental Pollution: definition, cause, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.
12.	Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting and watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust and dies.
13.	Wasteland reclamation. Consumerism and waste products. 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. Public awareness.
14.	Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.
15.	Disaster Management: Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.
16.	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.
17.	Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community – based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Topics in Practical:

S. No.	Topics
1.	Study of natural ecosystem: Pond, river, and forest. and artificial ecosystem: etc.
2.	Study of artificial ecosystem: Crop land ecosystem
3.	Identification of common plants, insects and birds

4.	Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
5.	Pollution Case Studies: case study and visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain.

Suggested Readings:

- Environmental Science - Bharucha Erach, 2017, University Grant Commission
- Environmental and Ecology - Hussain Majid,2013, Online book
- Environmental Biotechnology - Agrawal SK,2002, APH Publishing Corporation, New Delhi
- Introduction to Environment Science – Sharma JP,2003, Laxmi Publication, New Delhi
- Environment Geography – Singh Svindra,2015, Pryaga Pustak Bhawan, Allahabad
- Ecology and Environment – Ojha AK, 2017, Bodhik Publication, Allahabad

53. EVS – 321 (Principles of Food Science and Nutrition)

Credit Hours: 2 (2+0)

Topics in Theory:

S. No.	Topics
1.	Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.);
2.	Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bioactives, important reactions)
3.	Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods)
4.	Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.)
5.	Food and nutrition, Malnutrition (over and under nutrition),
6.	Nutritional disorders; Energy metabolism (carbohydrate, fat, proteins)
7.	Balanced/ modified diets, Menu planning,
8.	New trends in food science and nutrition
9.	Enzymes: General properties; Classification; Mechanism of action; Michaelis & Menten and Line Weaver Burk equation & plots; Introduction to allosteric enzymes
10.	Nucleic acids: Importance and classification; Structure of Nucleotides, A, B & Z DNA; RNA: Types and Secondary & Tertiary structure.
11.	Metabolism of carbohydrates: Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain.
12.	Metabolism of lipids: Beta oxidation, Biosynthesis of fatty acids.

Suggested Readings:

- Srilakshmi, B. (2010). Text Book of Food Science. New age international (P) limited, publisher, New Delhi
- Sehgal, S. and Raghuvanshi, R.S. (2007). Text Book of Community Nutrition, ICAR Publication

Department - Soil Science and Agricultural Chemistry

54. SAC – 111 (Fundamentals of Soil Science)

Credit Hours: 3 (2+ 1)

Topics in Theory:

S. No.	Topics
1.	Definitions of Soil, as a natural body, Soil Profile, components of soil;
2.	Pedological and edaphological concepts of soil;
3.	Soil genesis: soil forming rocks and minerals;
4.	Weathering, processes and factors of soil formation
5.	Soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity
6.	Elementary knowledge of soil taxonomy classification and soils of India
7.	Soil water retention, movement and availability
8.	Soil air, composition, gaseous exchange, problem and plant growth
9.	Soil temperature; source, amount and flow of heat in soil; effect on plant growth
10.	Soil reaction-pH, soil acidity and alkalinity, buffering
11.	Effect of pH on nutrient availability
12.	Soil colloids - inorganic and organic components
13.	Silicate clays: constitution and properties
14.	Sources of charge; ion exchange,
15.	Cation exchange capacity & base saturation
16.	Soil organic matter: composition, properties and its influence on soil properties
17.	Humic substances - nature and properties
18.	Soil pollution - behaviour of pesticides and inorganic contaminants,
19.	Prevention and mitigation of soil pollution.
20.	Soil organisms: macro and microorganisms, their beneficial and harmful effects.

Topics in Practical:

S. No.	Topics
1.	Study of soil profile in field.
2.	Study of soil sampling tools, collection of representative soil sample, its processing and storage.
3.	Study of soil forming rocks and minerals.
4.	Determination of soil density, moisture content and porosity
5.	Determination of soil texture by feel and Bouyoucos Methods
6.	Studies of capillary rise phenomenon of water in soil column and water movement in soil.
7.	Determination of soil pH and electrical conductivity.

8.	Determination of cation exchange capacity of soil
9.	Study of soil map
10.	Determination of soil colour
11.	Demonstration of heat transfer in soil.
12.	Estimation of organic matter content of soil.

Suggested Readings:

- Baver, L.D. Gardener, W.H. and gardener W.R.(1976) Soil Physics Wiley Eastern Ltd, New Delhi
- Biswas, T.D. and Mukherjee, S.K. (2006) Text book of soil science. Tata McGraw Hill publishing Co. Ltd, New Delhi
- Brady, N.C. and Weil, R.R. (2002) The nature and properties of soils, prentice hall of India Pvt. Ltd, M-97, Connaught Circus, New Delhi
- Das, D.K. (2002) Introductory Soil Science, Kalyani publisher, New Delhi
- ISSS (2009) Fundamentals of Soil Science, Div. of Soil Science, IARI, New Delhi
- Chopra S.L. and Kanwar, J.S. (1991) Analytical Agricultural Chemistry, Kalyani publisher, Ludhiana 64
- Jackson, M.L. (1973) Soil chemical analysis, Prentice Hall of India, Pvt. Ltd New Delhi
- Piper, C.S. (1950) Soil and plant analysis. Hans publications, Bombay
- Richards, L.A. (1960) Diagnosis and improvement of saline and alkali soils., USDA agriculture Hand book 60, Washington D.C., USA
- Agarwal, R.R., Yadav, J.S.P. & Gupta, R.N. (1982) Saline and alkali soils of India. ICAR, New Delhi.
- Sehgal, J. (2000) Pedology: Concepts and applications, Kalyani publisher, Ludhiana

55. SAC – 221 (Problematic Soils and Their Management)

Credit Hours: 2 (2+0)

Topics in Theory:

S. No.	Topics
1.	Soil quality and health
2.	Distribution of Waste land and problem soils in India and their categorization based on properties
3.	Reclamation and management of Saline and sodic soils
4.	Acid soils, Acid Sulphate soils
5.	Eroded and Compacted soils
6.	Flooded soils
7.	Polluted soils
8.	Irrigation water – quality and standards,
9.	Utilization of saline water in agriculture
10.	Remote sensing and GIS in diagnosis and management of problem soils

11.	Multipurpose tree species, bio remediation of soils through MPTs
12.	Land capability and classification,
13.	Land suitability classification
14.	Problematic soils under different Agro-ecosystems

Suggested Readings:

- Bear FE. 1964. Chemistry of the Soil. Oxford & IBH.
- Jurinak JJ. 1978. Salt-affected Soils. Department of Soil Science & Biometeorology. Utah State Univ.
- USDA Handbook No. 60. 1954. Diagnosis and improvement of Saline and Alkali Soils. Oxford & IBH.
- Abrol, I.P. and Dhurva Narayana, V.V. (1998) Technologies for wasteland development, ICAR, New Delhi-110012
- Cirsan Paul, J.(1985) Principles of remote sensing. Longman, New York.
- Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils. USDA Hand book No. 60, Washington, DC USA.
- Somani, L.L. and Totawat, K.L. (1993). Management of salt affected soils and waters. Agrotech publishing Academy, Udaipur.
- Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. (1982). Saline Alkali soils of India, ICAR, New Delhi.
- ISSS (2009) Fundamentals of Soil Science, Div. of Soil Science, IARI, New Delhi
- Ganesh, A. (2015). GPS principles and Applications (e-books); Publisher Satish Serials.

56. SAC – 311 (Manures, Fertilizers and Soil Fertility Management)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Introduction and importance of organic manures,
2.	Properties and methods of preparation of bulky and concentrated manures.
3.	Green/leaf manuring.
4.	Fertilizer recommendation approaches.
5.	Integrated nutrient management.
6.	Chemical fertilizers: classification, ,
7.	Composition and properties of major nitrogenous, phosphatic, potassic fertilizers
8.	Secondary & micronutrient fertilizers,
9.	Complex fertilizers, nano fertilizers & Soil amendments,
10.	Fertilizer Storage, Fertilizer Control Order.
11.	History of soil fertility and plant nutrition
12.	Criteria of essentiality. role, deficiency and toxicity symptoms of essential plant nutrients

13.	Mechanisms of nutrient transport to plants,
14.	Factors affecting nutrient availability to plants
15.	Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients.
16.	Soil fertility evaluation,
17.	Soil testing. Critical levels of different nutrients in soil
18.	Forms of nutrients in soil, plant analysis, rapid plant tissue tests. Indicator plants
19.	Methods of fertilizer recommendations to crops
20.	Factor influencing nutrient use efficiency (NUE), methods of application under rainfed and irrigated conditions

Topics in Practical:

S. No.	Topics
1.	Introduction of analytical instruments and their principles
2.	Calibration and applications of analytical instruments
3.	Colorimetry and flame photometry
4.	Estimation of soil organic carbon
5.	Estimation of alkaline hydrolysable N in soils
6.	Estimation of soil extractable P in soils
7.	Estimation of exchangeable K; Ca and Mg in soils
8.	Estimation of soil extractable S in soils
9.	Estimation of DTPA extractable Zn in soils
10.	Estimation of N in plants.
11.	Estimation of P in plants
12.	Estimation of K in plants
13.	Estimation of S in plants

Suggested Readings:

- Biswas, T.D. and Mukherjee, S.K. (2006) Text book of soil science.Tata McGraw Hill publishing Co. Ltd, New Delhi
- Das, D.K. (2002) Introductory Soil Science, Kalyani publisher, New Delhi
- Rai, M.M. (2002) Principal of Soil Science, Mac Millan India Ltd, New Delhi
- ISSS (2002) Fundamental of Soil Science Div. of Soil Science, IARI, New Delhi
- Jackson, M.L. (1973) Soil chemical analysis, Prentice Hall of India, Pvt. Ltd New Delhi
- Piper, C.S. (1950) Soil and Plant analysis, .Hans publications, Bombay
- Singh Dhyan, Chhonkar, P.K. and Dwivedi V.S. (2005) Manual on Soil Plant and water analysis. Westville Publishing House, New Delhi
- Tisdale, S.L. Nelson, W.L. Beaton, J.D. and Havlin, J.L.(1991) Soil fertility and fertilizers (5th ed.).Prentice Hall of India, Pvt . Ltd, New Delhi.

- Singh Vinay (1996) (Hindi) Soil Science, fertilizer & Manures , V.K. Prakashan Barot Meerut (U.P)
- Yawalkar, K.S. and Agarwal. J.P. (1992). Manure and fertilizers. Agriculture Horticulture Publishing House, Nagpur.
- Macself, A.J. (2015) Soils and Fertlizers (e-book) Publisher Satish Serial.
- Rajkumar, G. R. (2016). Soil Chemistry, Fertility and Fertlizers (e-book): Publisher Satish Serial

57. SAC – 312 (Bio-pesticides & Bio-fertilizers)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	History and concept of bio-pesticides
2.	Importance, scope and potential of bio-pesticide
3.	Definitions, concepts and classification of bio-pesticides viz. pathogen, botanical pesticides, and bio-rationales
4.	Botanicals and their uses
5.	Mass production technology of bio-pesticides
6.	Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes
7.	Methods of application of bio-pesticides
8.	Methods of quality control and Techniques of bio-pesticides.
9.	Impediments and limitation in production and use of bio-pesticide
10.	Bio-fertilizers - Introduction, status and scope
11.	Structure and characteristic features of bacterial bio-fertilizers- Azo-spirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frakia; Cynobacterial
12.	Bio-fertilizers- Anabaena, Nostoc, Hapalosiphon and fungal biofertilizers- AM mycorrhiza and ectomycorhiza.
13.	Nitrogen fixation -Free living and symbiotic nitrogen fixation.
14.	Mechanism of phosphate solubilization and phosphate mobilization, K solubilization.
15.	Production technology: Strain selection, sterilization, growth and fermentation,
16.	Mass production of carrier based and liquid bio-fertilizers.
17.	FCO specifications and quality control of bio-fertilizers
18.	Application technology for seeds, seedlings, tubers, sets etc.
19.	Bio-fertilizers -Storage, shelf life, quality control and marketing.
20.	Factors influencing the efficacy of bio-fertilizers

Topics in Practical:

S. No.	Topics
1.	Isolation and purification of important bio-pesticides
2.	Trichoderma Pseudomonas, Bacillus, Metarhyzium etc. and its production

3.	Identification of important botanicals.
4.	Visit to biopesticide laboratory in nearby area.
5.	Field visit to explore naturally infected cadavers
6.	Identification of entomo-pathogenic entities in field condition. Quality control of bio-pesticides.
7.	Isolation and purification of Azospirillum , Azotobacter, Rhizobium, P-solubilizers and cyanobacteria
8.	Mass multiplication and inoculums production of bio-fertilizers
9.	Isolation of AM fungi -Wet sieving method and sucrose gradient method
10.	Mass production of AM inoculants

Suggested Readings:

- Lakshman, H.C. (2014) Bio-fertilizers and Bio-pesticides. Pointer Publishers
- Sylvia D.N. 2005; Principles and application of Soil Microbiology. Peason Publisher.
- Project Directorate of Biological control. 1994. Technology for mass production of natural enemies. Technical Bulletin-4.
- Rabindra, R.J., Kennedy, J.S., Sathaiah, N., Rajeshkharan, B. and Srinivasan, M.R. 2001. Microbial control of crop pests. TNAU.
- Dhaliwal, GS & Koul O. 2007. Biopesticides and pest management. Kalyani Publ., New Delhi

Cambridge

- 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. Madress
- Narayanaswamy V R 1979. *Strengthen your writing*, Orient Longman, New Delhi Sharma R C and Krishna Mohan 1978. *Business Correspondence*, Tata Mc Graw Hill publishing Company, New Delhi

60. HVE – 112 (Human Values and Professional Ethics)

Credit Hours: 1(1+0)

Topics in Theory:

S. No.	Topics
1.	Understanding the need, content and process for Value Education
2.	Self-exploration: its content and process, Continuous happiness and prosperity: A look at basic human aspirations.
3.	Right understanding, and Relationship and physical facilities.
4.	Harmony in the human being: Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
5.	Understanding the needs of Self (T) and Body.
6.	Understanding the harmony of 'I' with the body: *Sanyam*, and *Swasthya.*
7.	Understanding values in human – human relationship: meaning of *Nyaya* and programme for its fulfillment to ensure *Ubhay-tripti.*
8.	Trust (*Vishwas*),and Respect (*Samman*), as the foundational values of relationship.
9.	Understanding the harmony in the society (society being an expression of family): *Samadhan*, *Samridhi*, *Abhay, Sah-astitva* as comprehensive human Goals.
10.	Understanding the harmony in the Nature; Interconnectedness and mutual fulfilment among the four orders of nature.
11.	Recyclability and self- regulation in nature.
12.	Understanding existence as co-existence (*sah-astitva)* of mutually interacting units.
13.	Understanding existence as co-existence (*sah-astitva)* of mutually interacting units.
14.	Natural acceptance of human values.
15.	Definitiveness of ethical Human Conduct, Basis for humanistic Education, humanistic Constitution and universal Human Order;
16.	Competence in Professional Ethics. Case studies of typical holistic technologies, management models and production systems.
17.	Role of gender in promoting inclusivity and understanding of diverse human values and ethical perspectives
18.	Convergence of gender perspectives with identity, equality, equity sensitization against gender stereotype and glass- ceiling in the social institutions.
19.	Gender- awareness, planning, mainstreaming and redistributive policies to augment the

	value system in agriculture
20.	Gender equity and gender issues, constitutional obligations like values, rights, duties, and responsibilities of citizens, lecture series on tolerance and harmony, towards diversities related to cultural, regional, linguistic, socio-economic conditions.

Topics in Practical:

S. No.	Topics
1.	Introduce yourself in detail, what are the goals in your life? How do you set your goals in your life? How do you differentiate between right and wrong?
2.	List down all your important desires. Observe whether the desire is related to Self (I'') or body. If it appears to be related to body or both visualize, which part of it is related to self (I) and which part is related to Body.
3.	Observe any physical facility you use follows the given sequence with time: Necessary and tasteful → unnecessary but still tasteful → unnecessary and tasteless → intolerable.
4.	Chalk out some programmes towards ensuring your harmony with the body- in terms of nurturing, protection and right utilization of the body.
5.	Observe, on how many occasions, you are able to respect your related ones (by doing the right evaluation) and on how many occasions you are disrespecting by way of under evaluation, over evaluation or otherwise evaluation.
6.	List down some common units (things) of Nature which you come across in your daily life and classify them in the four orders of nature. Analysis and explain the aspect of mutual fulfilment of each unit with other orders.
7.	Make a chart to show the whole existence as co-existence. With the help of this chart try to identify the role and the scope of some of the courses or your study.
8.	Identify any two important problems being faced by the society today and analyse the root cause of these problems. Can these be solved on the basis of natural acceptance of human values? If so, how should one proceed in this direction from the present situation?

Suggested Readings:

- R.R. Gaur, R. Sangal, G.P. Bagaria, 2009: A Foundation Course in human Values and Professional Ethics, Excel Books, New Delhi.
- Donella H, Meadows, Dennis L., Jorgen Randers, William W., Behrens III, 1972, Limits to Growth – Club of Rome report, Universe Books.
- Anagraj, 1998, Jeevan Vidyaek Parichay, Divya Path Sansthan, Amarkantak.
- P.L. Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
- A.N. Tripathy, 2003, Human Values, New Age International Publishers.
- Subhash Palekar, 2000, how to practice natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
- M. Govindrajran, S Natrajan and V.S. Senthil Kumar, Engineering Ethics (including human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
- B.P. Bannerjee, 2005, Foundations of Ethics and Management, Excel Books.
- B.L. Bajpai, 2004, Indian Ethos and Modern Management, New Royal book Co. Lucknow, Reprinted 2008.

PROGRAMME-2

B.Sc. (Hons.)

Horticulture

Department – Basic Sciences

1. PBC – 121 (Elementary Plant Biochemistry)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Carbohydrates: Occurrence, classification and structure, physical and chemical properties of carbohydrates, isomerism, optical activity, reducing property, reaction with acids and alkalis, ozone formation.
2.	Lipids: Classification, important fatty acids and triglycerides, essential fatty acids. Physical and chemical properties of oils, rancidity, phospholipids, types and importance.
3.	Plant pigments – structure and function of chlorophyll and carotenoids.
4.	Sterols, basic structure, role of brassino sterols in plants.
5.	Proteins: Classification, function and solubility, amino acids – classification and structure, essential amino acids, properties of amino acids, colour reactions, amphoteric nature and isomerism; structure of proteins –primary, secondary tertiary and quaternary structure and reaction of proteins.
6.	Enzymes: Classification and mechanism of action; factors affecting enzyme action
7.	Coenzymes and co-factors.
8.	Vitamins and minerals as co-enzymes/co-factors.
9.	Carbohydrate metabolism – glycolysis and TCA-cycle;
10.	Metabolism of lipids, biosynthesis of fatty acids, fatty acid oxidation
11.	Electron transport chain, bioenergetics of glucose and fatty acids
12.	Structure and function of nucleic acid, replication, transcription and translation.

Topics in Practical:

S. No.	Topics
1.	Preparation of standard solutions and reagents
2.	Carbohydrates: Qualitative reactions and test
3.	Estimation of starch; Estimation of reducing and non-reducing sugars from fruits
4.	Amino acids: Reactions of amino acids
5.	Proteins: Estimation of proteins by Lowry's method
6.	Fatty acids: Estimation of free fatty acids, acid value determination
7.	Determination of iodine number of vegetable oils
8.	Vitamins: Estimation of Ascorbic acid
9.	Techniques: Paper chromatography
10.	Thin layer chromatography
11.	Electrophoresis of pigments extracted from flowers
12.	Extraction of oil from oil seeds

13.	Enzymes: Enzyme assay, Enzyme

Suggested Readings:

- Lehninger, Nelson, D. L. and Michael, M. C. 2004. *Principles of Biochemistry.* Freeman Publishers
- Narayanan L M. Biochemistry. Saras Publications.
- Bose. Developments in Physiology Biochemistry & Molecular Biology of Plants Vol.-1. New India Publications.689
- Voet, D and Voet J. G. 2004. Biochemistry 4th Edition. Wiley & sons Publishers. USA.
- Sadashiv, S and Manickam, A. 1996. Biochemical methods for Agricultural sciences. New age International Publishers, New Delhi.
- Voet, D. and Voet, J.G. 2004. (3rd edit). Biochemistry. John Wiley & sons Incl.USA.
- Rameshwar, A. 2006. (3rd edit). Practical Biochemistry. Kalyani Publishers, New Delhi.
- Buchanan, B. B., Gruissem, W. and Jones, R. L. 2002. Biochemistry and molecular biology of plants. 2nd edition. Blackwell publications, UK.

2. EPB – 221 (Elementary Plant Biotechnology)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Concepts of Plant Biotechnology
2.	History of Plant Tissue Culture and Plant Genetic Engineering; Scope and importance in Crop Improvement
3.	Totipotency and Morphogenesis
4.	Nutritional requirements of in-vitro cultures
5.	Techniques of In-vitro cultures
6.	Micro propagation
7.	Anther culture and Pollen culture
8.	Ovule culture and Embryo culture
9.	Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture
10.	Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology
11.	Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids
12.	Applications in crop improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer
13.	Transgenic plants and their applications. Blotting techniques
14.	DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in crop improvement.
15.	Nanotechnology: Definition and scope, types of nano material and their synthesis, green

- Noggle G.R and Fritz T.G.1944. Introductory Plant Physiology.
- Pandey and Sinha. Plant Physiology.692
- JKA Bleasdale, Plant Physiology in relation to Horticulture
- Amarjit Basra, Plant Growth Regulators in Agriculture and Horticulture: Their role &Commercial Uses
- Rajendran, Ramamoorthy and S. Juliet Hepziba, Nutritional and Physiological Disorders in Crop Plants

6. PPT – 111 (Introductory Microbiology)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	History and Scope of Microbiology
2.	The discovery of micro-organism, spontaneous generation conflict, germ theory of diseases, microbial effect on organic and inorganic matter.
3.	Development of microbiology in India and composition of microbial world.
4.	Microscopy and Specimen Preparation: The bright field microscope, fixation, dyes and simple staining, differential staining.
5.	Difference between prokaryotic and eukaryotic cells. Prokaryotic cell structure and functions. Plant pathogenic bacteria
6.	Types of culture media and pre-culture techniques. Microbial growth in models of bacterial, yeast and mycelial growth curve. Measurement of bacterial growth
7.	General properties of viruses and brief description of bacterophages.
8.	DNA as genetic material.
9.	Antibiosis, symbiosis, intramicrobial and extra-microbial association
10.	Sterilization methods- physical and chemical, isolation of pure cultures and preservation of cultures
11.	Plant growth promoting microorganisms
12.	Mushrooms- economical importance, mushrooms edible and poisonous type, nutritive values, culturing and production techniques.
13.	Industrially important microorganism in large scale production and common microbial fermentations.

Topics in Practical:

S. No.	Topics
1.	Examination of natural infusion and living bacteria
2.	Examination of stained cells by simple staining and gram staining
3.	Method for sterilization and nutrient agar preparation
4.	Broth culture, agar slopes, streak plates and pour plats, turbid metric estimation of

	microbial growth.
5.	Mushroom culture-spawns production, culture and production techniques, harvesting packing and storage.

Suggested Readings:

- M T Madigan, and J M Martinko, 2014. Brock Biology of Microorganisms 14th Edn. Pearson.
- M J Pelczer, 1998. Microbiology 5th Edn. Tata Mc. Grow Hill Education Pvt. Ltd.
- Stainer, R, 1987. General Microbiology. Palgrave Macmillan.
- Edward Alchano, 2002. Introduction to Microbiology. Jones and Bartlett hearing.
- R P Singh, 2007. General Microbiology. Kalyani Publishers.
- J Heritage, E G V Evans, R A Killington, 2008. Introductory Microbiology. Cambridge University press P. date.
- Pelczar, jr. M.J.E.C.S. Chan and Krieg, N.R. 1996. Microbiology. Mc Graw Hill Publishers, New York.
- Prescott, L.M. Harley, J.P. and Klein, D.A (5ed) 2002. Microbiology. Mc Graw Hill Publishers, Newyork.

8.	Digging, labelling and packing of nursery fruit plants. Maintenance of nursery records
9.	Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery
10.	Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance
11.	Nutrient and plant protection applications during nursery

Suggested Readings:

- Hudson T. Hartmann, Dale E. Kester, Fred T. Davies, Jr. and Robert L. Geneve. Plant Propagation- Principles and Practices (7th Edition). PHI Learning Private Limited, New Delhi-110001
- T. K. Bose, S. K. Mitra, M. K. Sadhu, P. Das and D. Sanyal. 2005. Propagation of Tropical & Subtropical Horticultural Crops, Volume 1(3rd Revised edition). Naya Udyog, 206, Bidhan Sarani, Kolkata 700006
- Guy W. Adriance and Feed R. Brison. Propagation of Horticultural Plant. Axis Books (India).
- 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.
- Hartman, H. T. and Kester, D. E. Plant Propagation Principles and practices. 1976. Prentice hall of India Pvt. Ltd., Bombay
- Sadhu, M.K.1996. Plant Propagation. New age International Publishers, New Delhi.
- Mukhergee, S. K. and Majumdar, P. K. 1973. Propagation of fruit crops. ICAR, New Delhi.
- Ganner, R.J. and Choudhri, S.A. 1972. Propagation of Tropical fruit trees, . Oxford and IBN publishing Co., New Delhi.
- Sarma, R. R. 2002. Propagation of Horticultural Crops. Kalyani Publishers,(Principles and practices) New Delhi.
- Symmonds, 1996. Banana, .II edition, Longman, London.
- Chundawat, B.S. . 1990. Arid fruit culture. Oxford and IBH, New Delhi
- Chadha, K.L. 2002. Hand book of Horticulture. (ICAR), ICAR, New Delhi.

8. FSC – 111 (Fundamentals of Horticulture)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Scope and importance, classification of horticultural crops, branches of horticulture, general features of horticulture
2.	Nutritive value: Functions of fruits and vegetables in human body, importance and role of essential minerals and vitamins for human body, difference between fruits and vegetables
3.	Area and production, exports and imports, research organisations in India
4.	Fruit and vegetable zones of India and of different states, and classification of

	horticultural crops based on different criteria
5.	Nursery techniques and their management, soil and climate
6.	Propagation -Definition, need, sexual and asexual/vegetative method of propagation and their advantages and disadvantages, different vegetative methods of propagation of plants and their merits and demerits
7.	Vegetable gardens, nutrition and kitchen garden and other types of gardens Guidelines/principles/importance and layout in planning vegetable gardens
8.	Planting systems, planting densities and management of orchards
9.	Objective of orchard management, Resources for better comprehension of orchard management and their advantages and disadvantages
10.	Production and practices for fruit, vegetable and floriculture crops: selection of crop, soil and climate, suitable variety(ies), field preparation, spacing, manuring and fertilizers, plant protection aids, harvesting
11.	Types and methods of pruning and training of fruit crops, factors to be considered in pruning strategy for pruning, frame pruning, maintenance pruning, renewal pruning
12.	Plant growth Regulators -Definition of plant growth regulator, significance of growth regulator, types of phytohormones, role of growth regulators in horticultural crops, method of application of growth regulators
13.	Water management: why plants need application of water, definition of irrigation, Factors affecting the supply of irrigation water to plants, time of irrigation, how much to irrigate, different systems of irrigation and their merits and demerits
14.	Weed management -Definition of weed, commonly observed weed species (monocot/dicot), Methods of weed control, Losses caused by weeds, integrated weed management
15.	fertility management in horticultural crops: organic and inorganic fertilizers, time of application, different methods of fertilizer application
16.	Cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits
17.	Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness
18.	Concept of rejuvenation of old orchards, why rejuvenation need in old orchards, top working, frame working
19.	Introduction of organic farming, principles of organic farming, steps involve in market chain management

Topics in Practical:

S. No.	Topics
1.	Features of orchard
2.	Planning and layout of orchard
3.	Tools and implements used for intercultural practices for orchard
4.	Identification of various horticultural crops

5.	Layout of nutrition garden
6.	Preparation of nursery beds for sowing of vegetable seeds
7.	Digging of pits for fruit plants
8.	Planting systems
9.	Training and pruning of orchard trees
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
14.	Assessment of bearing habits
15.	Maturity standards
16.	Harvesting, grading, packaging and storage

Suggested Readings:

- Prasad and Kumar, 2014. Principles of Horticulture, 2nd Edn, Agrobios (India).
- Neeraj Pratap Singh, 2005. Basic concepts of Fruit Science 1st Edn, IBDC Publishers.
- Gardner/Bardford/Hooker. J.R., 1957. Fundamentals of Fruit Production, Mac Graw Hill Book Co., New York.
- Edmond, J.B, Sen, T.L, Andrews, F.S and Halfacre R.G, 1936. Fundamentals of Horticulture, 1963Tata Mc Graw Hill Publishing Co., New Delhi.
- Kumar, N, 1990. Introduction to Horticulture, Rajyalakshmi publications, Nagarcoil, Tamilnadu.
- Jitendra Singh, Basic Horticulture, 2002. Kalyani Publishers, Hyderabad.
- Denisen E.L., 1957. Principles of Horticulture, MacMillan Publishing Co., New York.
- Chadha, K.L., 2002. Handbook of Horticulture, (ICAR), ICAR, New Delhi.
- 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.
- S. Prasad and U. Kumar, 2010. A handbook of Fruit Production, Agrobios (India).
- Jitendra Singh. 2011. Basic Horticulture, Kalyani Publications, New Delhi.

9. FSC – 124 (Tropical and Subtropical Fruits)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Horticultural classification of fruits including genome classification, Horticultural zones of India
2.	Mango: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural

	techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
3.	Banana: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
4.	Grapes: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
5.	Citrus: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
6.	Papaya: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
7.	Sapota: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
8.	Guava: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, Physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
9.	Pomegranate: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
10.	Bael and Ber: Detailed study of area, production and export potential, varieties, climate

	and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
11.	Aonla and Annona: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
12.	Fig and Pineapple: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
13.	Jackfruit and Avocado: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
14.	Mangosteen and Litchi: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
15.	Carambola and Durian: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
16.	Rambutan and Bilimbi: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
17.	Loquat and Rose apple: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage

18.	Breadfruit and Passion fruit: Detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning, management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards, physiological disorders, post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage
19.	Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures
20.	Seediness and kokkan disease in banana, citrus decline and casual factors and their management
21.	Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economics of production

Topics in Practical:

S. No.	Topics
1.	Description and identification of varieties based on flower and fruit morphology in Mango, banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael, ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian, rambutan, bilimbi, loquat, rose apple breadfruit and passion fruit
2.	Training and pruning of grapes, mango, guava and citrus.
3.	Selection of site and planting system
4.	Pre-treatment of banana suckers, desuckering in banana, sex forms in papaya
5.	Use of plastics in fruit production
6.	Visit to commercial orchards and diagnosis of maladies
7.	Manure and fertilizer application including bio-fertilizer in fruit crops
8.	Preparation and application of growth regulators in banana, grapes and mango
9.	Seed production in papaya, latex extraction and preparation of crude papain
10.	Ripening of fruits, grading and packaging
11.	Production economics for tropical and sub-tropical fruits
12.	Mapping of arid and semi-arid zones of India
13.	Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona

Suggested Readings:

- H. P. Singh and M. M. Mustafa, 2009. Banana-new innovations. Westville Publishing House, New Delhi.
- M. S. Ladaniya, 2013. Citrus Fruits. Elsevier, India post ltd.
- Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. Tropical and Sub-Tropical-Vol-I. Nayaudyog-Kolkata
- Rajput, CBS and Srihari babu, R., 1985. Citriculture. Kalyani Publishers, New Delhi.
- Chundawat, B.S., 1990. Arid fruit culture. Oxford and IBH, New Delhi.

- Chadha, K. L. (ICAR) 2002, 2001. Hand book of Horticulture. ICAR, New Delhi.
- Symmonds, 1996. Banana. II Edn. Longman, London.
- Radha, T. and Mathew, L., 2007. Fruit crops. New India Publishing Agency.
- W. S. Dhillon, 2013. Fruit Production in 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.
- F.S. Davies and L.G.Albrigo, 2001. Citrus, Cab International.

10. FSC – 216 (Temperate Fruit Crops)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Classification of temperate fruits
2.	Apple: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
3.	Pear: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
4.	Peach: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
5.	Apricot: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
6.	Plum: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
7.	Cherry: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
8.	Persimmon: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed

	management, harvesting, post-harvest handling and storage
9.	Strawberry: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
10.	Kiwi: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
11.	Queens land nut (Mecademia nut) and almond: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
12.	walnut and pecan nut: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
13.	Hazel nut and Chest nut: Detailed study of areas, production, productivity varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage
14.	Re-plant problem, rejuvenation
15.	Special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures
16.	Special production problems like alternate bearing problem and their remedies

Topics in Practical:

S. No.	Topics
1.	Nursery management practices of apple, pear, peach, apricot, plum, cherry, persimmon, strawberry, kiwi, Queens land nut (Mecademia nut), almond, walnut, pecan nut, hazel nut and chest nut
2.	Description and identification of varieties of apple, pear, peach, apricot, plum, cherry, persimmon, strawberry, kiwi, Queens land nut (Mecademia nut), almond, walnut, pecan nut, hazel nut and chest nut
3.	Manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach
4.	Manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in nut crops
5.	Visit to private orchards to diagnose maladies
6.	Working out economics for apple, pear, plum and peach

Suggested Readings:

	water conservation methods-terraces, contour bunds etc.
5.	Methods of control and impounding of run-off water-farm ponds, trenches, macro catch pits, etc.
6.	*In-situ* water harvesting methods, micro catchment, different types of tree basins etc.
7.	Methods of reducing evapotranspiration, use of shelter belts, mulches, antitranspirants, growth regulators, etc.
8.	Water use efficiency-need based, economic and conjunctive use of water, micro systems of irrigation etc.
9.	Selection of plants having drought resistance
10.	Special techniques, planting and after care-use of seedling races, root stocks, *in-situ* grafting, deep pitting/planting, canopy management etc.
11.	Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind

Topics in Practical:	
S. No.	**Topics**
1.	Study of rainfall patterns
2.	Contour bunding/trenching,
3.	Micro catchments
4.	Soil erosion and its control
5.	Study of evapotranspiration, mulches and micro irrigation systems
6.	Special techniques of planting and aftercare in dry lands
7.	Study of morphological and anatomical features of drought tolerant fruit crops.

Suggested Readings:

- Chundawat, B.S. 1990. Arid Fruit Culture. Oxford and IBH, New Delhi.
- P.L. Taroj, B.B. Vashishtha, D.G. Dhandar. 2004. Advances in Arid Horticulture. Internal Book Distributing Co., Lucknow.
- T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K. N. Sathesan. 2008. Management of Horticultural Crops. New India Publishing Agency.

12. AGR – 212 (Weed Management in Horticultural Crops)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	**Topics**
1.	Weeds: Introduction, harmful and beneficial effects of weeds.
2.	Classification of weeds.
3.	Propagation and dissemination of weeds.
4.	Weed biology and ecology.

5.	Crop weed association, crop weed competition and allelopathy.
6.	Concepts of weed prevention, control and eradication.
7.	Methods of weed control: mechanical, cultural, chemical and biological methods.
8.	Integrated weed management.
9.	Herbicides: advantages and limitation of herbicide usage in India.
10.	Herbicide classification, formulations, methods of application.
11.	Introduction to Adjuvants and their use in herbicides.
12.	Introduction to selectivity of herbicides.
13.	Compatibility of herbicides with other agro chemicals.
14.	Weed management in major field and horticultural crops.
15.	Shift of weed flora in cropping systems.
16.	Aquatic and problematic weeds and their control.

Topics in Practical:

S. No.	Topics
1.	Identification of weeds.
2.	Survey of weeds in crop fields and other habitats.
3.	Preparation of herbarium of weeds.
4.	Calculations on weed control efficiency and weed index.
5.	Herbicide label information
6.	Computation of herbicide doses.
7.	Study of herbicide application equipment and calibration.
8.	Demonstration of methods of herbicide application.
9.	Preparation of list of commonly available herbicides.
10.	Study of phytotoxicity symptoms of herbicides in different crops.
11.	Biology of nut sedge, bermuda grass, parthenium and celosia.
12.	Economics of weed control practices.
13.	Tours and visits of problem areas.

Suggested Readings:

- Crafts, A.S. and Robbins, W.W. 1973. Weed Control. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Gupta, O.P. 1984. Scientific Weed Management. Today and Tomorrow Printers and Publishers, New Delhi.
- Gupta, O.P. 2015. Modern Weed Management. Agro Bios (India), Jodhpur.
- Naidu, V.S.G.R., Handbook of Weed Identification. Directorate of Weed Research, Jabalpur.
- Rajagopal, A., Aravindan, R. and Shanmugavelu, K.G., 2015. Weed Managementof Horticultural Crops. Agrobios (India), Jodhpur.

17. PSMA – 222 (Plantation Crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization
2.	Coconut: Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, weed and water management, nutrition, role of growth regulators, soil management, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics
3.	Arecanut: Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, weed and water management, nutrition, role of growth regulators, soil management, liming practices, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics
4.	Oil palm: Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, weed and water management, nutrition, role of growth regulators, soil management, physiological disorders, harvesting, post-harvest handling and processing
5.	Palmyrah palm: Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, weed and water management, nutrition, foliar feeding, role of growth regulators, soil management, physiological disorders, harvesting, post-harvest handling and processing
6.	Cacao: Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics
7.	Cashew nut: Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micropropagation, planting systems and method, gap filling, systems of cultivation, mulching, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics
8.	Coffee: Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics

9.	Tea: Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics
10.	Date palm: Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, weed and water management, nutrition, role of growth regulators, soil management, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics
11.	Rubber: Soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, weed and water management, nutrition, foliar feeding, role of growth regulators, soil management, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics

Topics in Practical:

S. No.	Topics
1.	Description and identification of coconut varieties
2.	Selection of Coconut and Arecanut mother palm and seed nut, planting of seed nuts in nursery
3.	Layout and planting of Coconut, Arecanut, Oil palm, Cashew nut, Cocoa gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao
4.	Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee
5.	Epicotyl, softwood, grafting and top working in cashew, working out the economics and Project preparation for Coconut, Arecanut, Oil palm, Cashew nut, Cocoa, etc.
6.	Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea

Suggested Readings:

- Kumar, N.J.B. M. Md. Abdul Khaddar, Ranga Swamy, P. and Irrulappan, I. 1997. Introduction to spices, Plantation crops and Aromatic plants. Oxford & IBH, New Delhi.
- Thampan, P.K. 1981.Hand Book of Coconut Palm. Oxford IBH, New Delhi.
- Nair, M.K., Bhaskar Rao, E.V.V., Nambiar, K.K.N. and Nambiar, M.C. 1979. Cashew, CPCRI, Kerala.
- Wood, GAR, 1975. Cacao. Longmen, London.
- Ranganadhan, V. 1979. Hand Book of Tea Cultivation. UPASI Tea Research Station, Cinchona.
- Thompson, P.K. 1980. Coconut. Oxford & IBH Publishing Co. Ltd., New Delhi.

Department – Floriculture and Landscape Architecture

18. FLA – 111 (Principles of Landscape Architecture)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Historical importance of Indian gardens
2.	Gardens of ancient world
3.	Famous gardens of India and abroad
4.	Types of garden- formal, informal, wild and free style
5.	Basic themes of garden- circular, rectangular and diagonal themes
6.	Use of Auto CAD and Archi CAD in designing gardens
7.	Factors affecting landscape design- initial approach, view, human choice, simplicity, topography etc.
8.	Principles of landscape gardening- axis, rhythm, balance, time and light, space, texture, form, mass effect, focal point, mobility, emphasis, unity, harmony etc
9.	Elements of landscape garden- tangible and intangible elements
10.	Bio- aesthetic planning- definition and objectives
11.	Planning and designing of home gardens, colonies, country planning and urban landscape
12.	Development of institutional gardens, avenue planting, beautifying schools, railway lines, railway stations, factories, bus stands, air ports, corporate buildings, dams, hydro electric stations, river banks, play grounds
13.	Gardens for places of religious importance- temples, churches, mosques, tombs etc
14.	Importance, features and establishment of English gardens, Japanese gardens, Mughal gardens, French gardens, Persian gardens, Italian gardens, Hindu- Buddhist gardens
15.	Xeriscaping- definition, principles and practice

Topics in Practical:

S. No.	Topics
1.	Study of garden tools and equipment
2.	Study of graphic language
3.	Use of drawing equipment, graphic symbols and notations in landscape designing
4.	Study and designing of different styles of gardens
5.	Study and designing of gardens based on different themes
6.	Designing gardens using AutoCAD/ ArchiCAD
7.	Designing gardens for homes, traffic islands, schools and colleges
8.	Designing gardens for public buildings and factories

9.	Designing gardens for railway stations and airports
10.	Designing gardens for temples and churches
11.	Designing gardens for play grounds and corporate buildings/ malls
12.	Designing and planting avenues for state and national highways
13.	Design and establishment of Japanese and English gardens
14.	Design and establishment of Mughal gardens
15.	Visit to public, institutional and botanical gardens

19. FLA – 324 (Breeding and Seed Production of Flower and Ornamental Crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	History of improvements of ornamental plants, centre of origin of flower crops and ornamental crops
2.	Objectives and techniques in ornamental plant breeding
3.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants., Rose, Jasmine
4.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants. Chrysanthemum,
5.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants Tuberose
6.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants Gerbera, Gladiolus
7.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants Dahlia, Heliconia, Lilium
8.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants Gaillardia, Petunia, *Hibiscus*
9.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants Bouganvillea, Zinnia, Cosmos
10.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants Dianthus, Snapdragon, Pansy, crossandra
11.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants marigold, , geranium, antirrhinium
12.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants china aster, orchids,
13.	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants anthurium, carnation, hibiscus
14.	Breeding for disease resistance
15.	Development of promising cultivars of important ornamentals and flower crops

16.	Role of heterosis and its exploitation
17.	Production of F1 hybrids and utilization of male sterility
18.	Production of open pollinated seed
19.	Harvesting, processing and storage of seeds,
20.	Seed certification.

Topics in Practical:

S. No.	Topics
1.	Study of floral biology and pollination in important species and cultivars Rose, Jasmine, Chrysanthemum, Tuberose, Gerbera, Gladiolus, dahlia Heliconia, Lilium, Gaillardia, Petunia, Hibiscus, Bouganvillea, Zinnia, Cosmos, Dianthus, Snapdragon, Pansy, crossandra, marigold, , geranium, antirrhinium, china aster, orchids, anthurium, carnation, hibiscus
2.	Techniques of inducing polyploidy and mutation
3.	Production of pure and hybrid seeds
4.	Practice in seed production methods

Suggested Readings:

- B.P. Pal. The Rose in India.1966.Directorate of Knowledge management in Agriculture, Indian council of Agriculture Research-New Delhi.
- T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy. 2003. Commercial flowers. Partha Sankar Basu, Nayaudyog, 206, Bidhan Sarani, Kolkata-700006.
- S.K. Bhattacharjee and L.C. De. 2003. Advanced Commercial Floriculture. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.
- D.J. Callaway and M.B. Callaway. 2000. Breeding Ornamental Plants. Timber Press
- A.J.Salaria and B.S.Salaria . 2011.A_2 Z Horticulture at a glance-III .INTLLECTS –Nurture to excel Jammu

20. FLA – 212 (Commercial Floriculture)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Scope and importance of commercial floriculture in India
2.	Production technology of rose
3.	Production technology of marigold
4.	Production technology of chrysanthemum
5.	Production technology of orchids
6.	Production technology of carnation
7.	Production technology of gladiolus

8.	Production technology of jasmine
9.	Production technology of crossandra
10.	Production technology of anthurium
11.	Production technology of dahlia
12.	Production technology of tuberose
13.	Production technology of bird of paradise
14.	Production technology of China Aster
15.	Production technology of gerbera
16.	Production techniques of foliage and filler materials
17.	Growing of flowers under protected environments- glass house, plastic house etc.
18.	Post-harvest technology of cut flowers in respect of commercial flower crops
19.	Flower dehydration techniques
20.	Production techniques for bulbous ornamentals

Topics in Practical:

S. No.	Topics
1.	Identification of commercially important floricultural crops
2.	Propagation practices in chrysanthemum
3.	Sowing of seeds and raising of seedlings in annuals
4.	Propagation by cutting, layering, budding and grafting
5.	Training and pruning of roses
6.	Use of chemicals and other compounds for prolonging the vase life of cut flowers
7.	Drying and preservation of flowers
8.	Flower arrangement practices

Suggested Readings:

- Bhattacharjee SK. 2018. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Reprint, pp. 2065.

21. FLA – 223 (Ornamental Horticulture)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	History, definition and scope of ornamental horticulture
2.	Floriculture industry
3.	Importance, area and production of floricultural crops
4.	Industrial importance of ornamental plants and flowers
5.	Importance and classification of ornamental plants
6.	General cultivation aspects of flowering annuals
7.	General cultivation aspects of herbaceous perennials
8.	General cultivation aspects of grasses, reeds and bamboos
9.	General cultivation aspects of bulbous ornamentals
10.	General cultivation aspects of shrubs
11.	General cultivation aspects of climbers
12.	General cultivation aspects of trees
13.	General cultivation aspects of indoor plants
14.	General cultivation aspects of palms and cycads
15.	General cultivation aspects of ferns and selaginella
16.	General cultivation aspects of cacti and other succulents
17.	Importance, design and establishment of garden features/ components- hedge, edge, borders, flower beds, bridges, paths, drives, fences
18.	Importance, design and establishment of garden features/ components- garden walls, gates, carpet bed, arbour, patio, decking, retaining walls
19.	Importance, design and establishment of garden features/ components- shade garden, sunken garden, roof garden, terrace garden, pebble garden
20.	Importance, design and establishment of garden features/ components- rockery, pools, water falls, fountains, bog garden, avenue planting and children garden
21.	Lawn- types, establishment and maintenance
22.	Importance of garden adornments- floral clock, bird bath, statues, sculpture, lanterns, water basins, garden benches etc.
23.	Importance of flower arrangement, Ikebana- techniques, types, suitable flowers and cut foliage
24.	Vertical garden, bottle garden, terrarium
25.	Art of making bonsai, culture of bonsai and maintenance

Topics in Practical:

S. No.	Topics

1.	Identification and description of flowering annuals
2.	Identification and description of biennials
3.	Identification and description of herbaceous perennials
4.	Identification and description of climbers
5.	Identification and description of shrubs
6.	Identification and description of indoor plants
7.	Identification and description of ferns and selaginella
8.	Identification and description of palms and cycads
9.	Identification and description of cacti and other succulents
10.	Planning, designing and establishment of garden features- lawn
11.	Planning, designing and establishment of garden features- hedge and edge
12.	Planning, designing and establishment of garden features- rockery
13.	Planning, designing and establishment of garden features- water garden
14.	Planning, designing and establishment of garden features- carpet bedding
15.	Planning, designing and establishment of garden features- shade garden
16.	Planning, designing and establishment of garden features- roof garden
17.	Study and creation of terrariums
18.	Study and creation of vertical gardens
19.	Study and practice of different types of flower arrangements
20.	Preparation of floral bouquets
21.	Preparation of floral rangoli
22.	Preparation of veni
23.	Study of bonsai techniques
24.	Bonsai practice and training
25.	Visit to nurseries and floriculture units

Suggested Readings:

- Adriance GW and Brison FR. 2000. Propagation of Horticultural Plants. Biotech Books, New Delhi, India.
- Bose TK, Mitra SK and Sadhu M K. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkata, India.
- Rajan S and Baby LM. 2007. Propagation of Horticultural Crops. New India Publ. Agency, New Delhi, India. pp. 251.

22. PSMA – 313 (Medicinal and Aromatic crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics

1.	History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India.
2.	Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements viz. aswagandha, safed musli, tulsi, kalmegh, lemon grass, citronella, opium, asalio, isabgol, satawar, mentha spp
3.	Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants.viz. asgandh, safed musli, tulsi, kalmegh, lemon grass, citronella, opium, asalio, isabgol, satawar, mentha spp.
4.	Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants.
5.	Therapeutic and pharmaceutical uses of important species.
6.	Storage techniques of essential oils. Medicinal Plants: Withania, periwinkle, Rauvolfia, Dioscorea, Isabgol, opium poppy, Ammi majus, Belladonna, Cinchona, Pyrethrum and other medicinal crops relevant to local conditions.
7.	Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, mentha, musk, occimum and other species relevant to the local conditions. Marketing.

Topics in Practical:

S. No.	Topics
1.	Collection and conservation of medicinal and aromatic plants from their natural habitat and their study morphological description,
2.	Nursery techniques of medicinal and aromatic crops.
3.	Harvesting of medicinal and aromatic crops.
4.	Curing and processing techniques of medicinal and aromatic crops.
5.	Extraction of essential oils.

Suggested Readings:

- Chadha, K.L. ICAR, 2001. Hand Book of Horticulture. Directorate of Information and Publications of Agriculture, Pusa, New Delhi.
- Azhar Ali Farooqui and Sreeramu, B.S. 2001. Cultivation of medicinal and aromatic plants.
- United Press Limited.
- Atal, E.K. and Kapur, B. 1982. Cultivation and Utilization of Medicinal and Aromatic plants.
- CSIR, New Delhi.
- Kumar, N. J.B.M. Md. Abdul Khaddar, Ranga Swamy, P. and Irulappan, I. 1997. Introduction to Spices, Plantation Crops Medicinal and Aromatic Plants.Oxford & IBH, New Delhi.
- Jain, S.K. 1968. Medicinal Plants .National Book Trust New Delhi. Oxford & IBH, New Delhi.
- Dastur, J.F. 1982. Medicinal plants of India Pakistan Taraprevala soms and co-private Ltd, Bombay

Department – Natural Resource Management

23. SAC – 111 (Fundamentals of Soil Science)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Composition of earth's crust, soil as a natural body – major components. Eluviations and alleviations formation of various soils
2.	Physical parameters; texture – definition, methods of textural analysis, stock's law, assumption, limitations, textural classes, use of textural triangle
3.	Absolute specific gravity/particle density, definition, apparent specific gravity/bulk density – factors influencing, bulk density. Relation between BD (bulk density), PD – practical problems. Pore space – definition and factors affecting capillary and non-capillary porosity
4.	Soil colour – definition, its significance, colour variable, value hue and chroma. Munsellcolour chart, factors influencing the color of soil
5.	Parent material, soil moisture, organic matter, soil structure, definition, classification, factors influencing genesis of soil structure.
6.	Soil consistency, plasticity, Atterberg's constants Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal
7.	Soil temperature, sources and distribution of heat, factors influencing, measurement
8.	Chemical properties, soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion and importance
9.	Soil water its forms, hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale
10.	Measurement of soil water, gravimetric – electric and densitometer methods – pressure plate and pressure membrane apparatus – Neutron probe – soil water movement – classification
11.	Aerial photography – satellite of soil features – their interpretation. soil orders; land capability classification
12.	Soil of different eco-systems and their properties. Rock & Minerals classification, Pathogenic process
13.	Objectives of soil science research institute in India (NBSS&LUP, ISSS, LTFE & NSSTL)
14.	Management of Soil Crusting, Soil Compaction and Soil Compression
15.	Soil Biology benefits and harmful effects.
16.	Methods and objective of soil survey, Remote sensing application in soil and plant Studies, Soil degradation

Topics in Practical:

S. No.	Topics
1.	Collection and preparation of soil samples
2.	Estimation of moisture, EC, pH and bulk density.
3.	Textural analysis of soil by Robinson's pipette method
4.	Description of soil profile in the field.
5.	Quantification of minerals and their abundance.
6.	Determination of Soil colour using Munsell Chart.
7.	Estimation of water holding capacity and hydraulic conductivity of soils.
8.	Estimation of Infiltration rate using double ring infiltrometer method.
9.	Estimation of soil moisture using gypsum block and neutron probe method
10.	Soil compaction measurement with Spectrometer.
11.	Determination of pore space of soil.
12.	Determination of filed capacity and permanent wilting point of soil.
13.	Determination of soil water potential characteristic curves by densitometer and pressure plate apparatus.
14.	Aggregate size distribution analysis of soil.
15.	Air capacity of soil by field method.

Suggested Readings:

- Brady Nyle C and Ray R Well, 2014. Nature and properties of soils. Pearson Education Inc., New Delhi.
- Indian Society of Soil Science, 2002. Fundamentals of Soil Science. IARI, New Delhi.
- Sehgal J. A., 2005. Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi.
- Dilip Kumar Das, 2015. Introductory Soil Science. Kalyani Publishers, Ludhiana.
- Biswas, T.D. and Mukharjee, S.K., 2015. Text Book of Soil science. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
- Brady, N.C., 1995. The Nature and properties of Soils. Macmillan Publishing Co, New York.
- Ghildyal, B.P. and Tripathi, R.P., 1987. Soil Physics. Acad. Press. New York.
- Kolay, A.K., 1983. Basic concepts of Soil Science. Wiley Eastern Ltd., New Delhi
- Brady, N. C. and Weil, R. R., 2010. Elements of the Nature and Properties of Soils (3rd Edition), Pearson Education, New Delhi.
- Foth, H.D., 1991. Fundamentals of Soil Science (8th Edition), John Wiley & Sons, New Delhi.
- Das, D .K., 2011. Introductory Soil Science (3rd Edition), Kalyani publisher, Ludhiana (India).
- Khan, T. O. 2013 Forest Soils: Properties and Management. Springer International Publishing, Switzerland
- Pritchett and Fisher RF, 1987. Properties and Management of Forest Soils. John Wiley, New York.
- Gupta, P.K. 2009. Soil, Plant, Water and Fertilizer Analysis (2nd Edition), AGROBIOS, Jodhpur

24. SAC – 122 (Soil Fertility and Nutrient Management)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Plant nutrients - classification and sources
2.	Essential and beneficial elements, criteria of essentiality
3.	Forms of nutrients in soil, mechanisms of nutrient transport to plants
4.	factors affecting availability of major, secondary and micro nutrients to plants
5.	Measures to overcome deficiencies and toxicities
6.	Soil fertility- different approaches for soil fertility evaluation
7.	Soil testing for available nutrients; Critical levels of different nutrients in soil
8.	Plant analysis- total and rapid tissue tests- critical levels of nutrients in plants
9.	DRIS method; Deficiency symptoms-indicator plants
10.	Biological method of soil fertility evaluation
11.	Soil test-based fertilizer recommendations to crops.
12.	Factors influencing nutrient use efficiency (NUE) in respect of N, P, K, S, Fe and Zn fertilizers
13.	Source, method and scheduling of nutrients for different soils and crops grown under rainfed and irrigated conditions.
14.	Integrated plant nutrient supply system and its management.

Topics in Practical:

S. No.	Topics
1.	Analytical Instruments- principles, calibration and applications
2.	Estimation of available nitrogen in soil
3.	Available phosphorous in soil
4.	Available potassium in soil
5.	Available sulphur in soil
6.	Estimation of exchangeable calcium and magnesium in soil
7.	Estimation of available micronutrients in soils
8.	Preparation of plant samples for analysis
9.	Estimation of nitrogen in plant
10.	Phosphorus and potassium in plants

Suggested Readings:

- Yawalkar K S, Agarwal JP and Bokde S, 1992. Manures and Fertilizers. Agri. Horticultural Publishing House, Nagpur.
- Tandon HLS, 1994. Fertilizers Guide. Fertilizers Development Consultation Organization, New

Fertilizers Technology. The Fertilizers Association of India, New Delhi

25. SAC – 223 (Soil, Water and Plant Analysis)

Credit Hours: 2(1+1)

Topics in Theory:

S. No.	Topics
1.	Methods of soil and plant sampling and processing for analysis.
2.	Characterization of hydraulic mobility – diffusion and mass flow.
3.	Methods of estimation of oxygen diffusion rate and redox potential.
4.	Soil micro-organisms and their importance.
5.	Saline, alkali, acid, waterlogged and sandy soils, their appraisal and management.
6.	Chemical and mineral composition of horticultural crops.
7.	Leaf analysis standards, index tissue, interpretation of leaf analysis values
8.	Quality of irrigation water different quality parameters.
9.	Management of poor quality irrigation water in crop management.
10.	Use of radio tracer techniques in soil fertility evaluation and plant nutrient studies.
11.	Rapid tissue tests for plant.
12.	Soil and Water pollution.

Topics in Practical:

S. No.	Topics
1.	Introduction to analytical chemistry
2.	Collection and preparation of soil, water and plant samples for analysis.
3.	Determination of pH, electrical conductivity
4.	Sodium adsorption ratio and exchangeable sodium percentage of soils.
5.	Estimation of available macro and micronutrient elements in soils and their contents in plants.
6.	Irrigation water quality analysis.
7.	Determination of pH and EC in irrigation water samples
8.	Determination of Carbonates and bicarbonates in soil and irrigation water
9.	Determination of Calcium and Magnesium in soil and irrigation water.
10.	Determination of N, P, K, Ca, Mg, S and micronutrients in plant samples.
11.	Determination of Sodium, Potassium, Chlorine and Boron in irrigation water.

Suggested Readings:

- H.L.S. Tandon. 2013, Methods of analysis of soil, plant, water and fertilizers. FDCO, New Delhi.
- Yawalkar,K.S.Agarwal,J.P.andBokde,S.,1977. ManuresandFertilizers. Agri-Horticultural Publish

- H.V.Nanjappa and B.K.Ramachandrappa, 2007. Manual on Practical Agricultural Meteorology. Agrobios India. Jodhpur.
- S.R.Reddy, 1999. Principles of Agronomy. Kalyani Publishers, New Delhi.
- T.Yellamanda Reddy and G.H.Sankara Reddi, 2010. Principles of Agronomy. Kalyani Publishers, New Delhi.
- Pattersen, S.1958. Introductionto Meteorology. Mc. Graw Hill Book Co. Inc., New York
- Tailor, J.T.1967. AgriculturalClimatology. Pergman Press Ltd., Headington Hill Hall, Oxford, England
- Trewarthe,T.G.1968. An Introduction to Climate. Mc Graw Hill Book Co. Inc., New York.
- Mavi,H.S.1985. Introduction to Agrometeorology. Oxford & IBH Publishing Co., New Delhi.

27. EVS – 122 (Environmental Studies and Disaster Management)#

Credit Hours: 3(2+1)

Topics in Theory:

S. No.	Topics
1.	Multidisciplinary nature of environmental studies Definition, scope and importance.
2.	Natural Resources: Renewable and non-renewable resources. Natural resources and associated problems.
3.	a)Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
4.	b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
5.	c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
6.	d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
7.	e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
8.	f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
9.	Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.
10.	Ecosystems, Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers.
11.	Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids.
12.	Introduction, types, characteristic features, structure and function of the following ecosystem:- a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem d. Aquatic-ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).
13.	Biodiversity and its conservation:-Introduction, definition, genetic, species & ecosystem

	diversity and biogeographical classification of India.
14.	Value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation.
15.	Hot-spots of biodiversity. Threats to biodiversity - habitat loss, poaching of wildlife, man-wildlife Conflicts Endangered and endemic species of India.
16.	Conservation of biodiversity: In-situ and Exsitu
17.	Environmental Pollution: definition, cause, effects and control measures of - Air, Water, Soil, Marine, Noise and Thermal pollution and Nuclear hazards.
18.	Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.
19.	Social Issues and the Environment: From Unsustainable to Sustainable development Urban problems related to energy, Water conservation, rain, water harvesting, watershed management, Environmental ethics: Issues and possible solutions.
20.	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, Water, Wildlife and Forest Conservation acts, Issues involved in enforcement of environmental legislation and Public awareness.
23.	Human Population and the Environment: population growth, variation among nations, population explosion.
24.	Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare.
25.	Role of Information Technology in Environment and human health.
26.	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves.
27.	Climatic change: global warming, Sea level rise, ozone depletion.
28.	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire.
29.	Air pollution, water pollution, deforestation, industrial waste water Pollution, road accidents, rail accidents, air accidents, sea accidents.
30.	Disaster Management-Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction.
31.	Concept of disaster management, national disaster management framework; financial arrangements.
32.	Role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Topics in Practical:

S. No.	Topics
1.	Visit to a local polluted site-Urban
2.	Visit to a local polluted site- Rural
3.	Visit to a local polluted site- Industrial
4.	Visit to a local polluted site- Agricultural
5.	Study of common plants
6.	Study of common insects
7.	Study of common birds
8.	Study of simple ecosystems-pond, river, hillslopes etc.
9.	Visit to local areas - river/forest/ grassland/catchment etc. to document components of ecosystem.
10.	Visit to industries to study pollution abatement techniques and case studies
11.	Solid waste management
12.	Human population and the Environment

Suggested Readings:

- Nandini, N. Suneetha and Sucharitha Tandon. Environmental Studies.
- Aswathanarayana, U. 1999. Soil resources and the environment. Oxford and IBH publishing Co., New Delhi. P. 173-195.
- D. D. Misra. Fundamental Concepts in Environmental Studies.680 Rep
- Diwan, P. and P. Diwan. 1998. Environmental Management Law and Administration. Variety Books International, New Delhi.
- Krishnamurthy. An Advanced Textbook on Biodiversity.
- S. Deshwal A. Deshwal. A Basic Course in Environmental Science.
- Erach Bharucha 2005.Textbook of environmental studies for under graduate courses.UGC,University press, Hyderabad.
- Manohara Chary and Jayaram Reddy 2004.Principles of Environmental studies BB publishers,Hyderabad.
- William, P. Cunning Ham and Mary Ann. Inquiry and applications Cunningham 2005.
- Principles of Environmental science. Tata MCG raw-hill publishing company limited, NewDelhi.
- Gupta, P.K. 2004 Methods in environmental analysis-water, soil and Air. Agro Bios (India).Jodhpur.
- Spencer R. Weart. The discovery of global warming.
- Daniel B. Botkin, Edward A. Keller. Environmental Science.
- Richard T. Wright and Bernard J. Nebel Environmental science: toward a sustainable agriculture.
- Linfield C.Brown. Pollution prevention and control.

Suggested Readings:

- K. Patra, 2013. Agroforestry – Principles and Practices. New India publishing agency.
- P. Dwivedi, 1992. Agroforestry – Principles and Practices. Oxford and IBH Publishing company.
- Dadhwal et al., 2014. Practical Manual on Agroforestry. Jaya publishing house, Delhi.
- L.K. Jha, 2015. Advances in Agroforestry. APH Publishing corporation, New Delhi.
- Linford, Jenny, 2007. A Concise Guide to Trees. Parragon books service limited, Parragon.
- Negi, S.S., 2007. Agroforestry Hand book. International book distributer, New Delhi.
- P.S. Pathak and Ram Newaj, 2010. Agroforestry – Potentials and Opportunities. Agrobios, Jodhpur
- Pankaj Panwar & Sunil Puri, 2007. Agroforestry: Systems & Practices. New India publishing agency, New Delhi.
- Ramesh Umrani and C.K. Jain, 2010. Agroforestry – Systems & Practices. ABD Publishers, New Delhi.
- Ramachandran Nair, P.K. 1993. An Introductionto 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.

29. AEG – 211 (Farm Power and Machinery)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Basic concepts of various forms of energy, unit and dimensions of force energy and power, calculations with realistic examples.
2.	Farm Power in India - Human, Animal, Mechanical And Electrical Energy Sources And Their Use In Agriculture
3.	Two Stroke and Four Stroke Engines, Working Principles, Applications - Types, Power and Efficiency
4.	Different Systems of IC Engine – Cooling, Lubricating, Fuel Injection Systems
5.	Tractors, Power Tillers and Their Types and Uses.
6.	Tillage - Objectives and Types, Furrow Terminology and Methods of Ploughing, Field Capacity And Field Efficiency

7.	Primary Tillage - Objectives, Mould Board Plough , Disc Plough, Chisel Plough, Sub-soiler , Components and Functions, Types, Advantages and Disadvantages
8.	Sowing Methods - Seed Drills, Seed Cum Fertilizer Drills - Components and Functions
9.	Implements For Intercultural Operations – Hoes, Long Handled Weeders, Cultivators, And Rotary Tillers
10.	Sprayers And Their Functions, Classification, Manually Operated Sprayers, Power Sprayers - Dusters, Types and Uses Sprayers
11.	Tools For Horticultural Crops – Propagation Tools, Planters and Harvesting Tools And Machinery
12.	Equipment For Land Development and Soil Conservation - Dozers, Levellers, Chisel Plough, Sub Soil Plough, Blade Harrow, Bund Former Land Levelling
13.	Cost Of Operation of Farm Machinery – Problem Solving
14.	Tractor And Implement Selection for Different Agricultural Operations
15.	Crop Harvesting Equipments: Potato Diggers, Fruit Pluckers, Tapioca Puller and Hoists.

Topics in Practical:

S. No.	Topics
1.	Calculation on force, power and energy
2.	IC engines – showing the components of dismantled engines and discussion about their functioning.
3.	Draw the neat sketch of engine components and discuss about them.
4.	Showing the components of dismantled motors and discuss about their parts.
5.	Draw the neat sketch of components of Induction motor and explain their importance.
6.	Showing different primary and secondary tillage implements and discussion about their parts, roles in operation.
7.	Adjustment of Suctions in Mould Board Plough
8.	Adjustment of Disc & Tilt Angle in Disc Plough
9.	Showing different Secondary tillage implements and discussion about their parts, roles in operation.
10.	Adjustment of hitching point and its operation
11.	Showing different types of Spraying equipments and their parts, calibration
12.	Draw the neat sketch of Knapsack sprayer and explain about its working
13.	Showing different types of Plant protection equipment and discussion about their parts, functioning etc.

Suggested Readings:

- T. P. Ojha and A.M. Michael. 2005. Principles of Agricultural Engineering (Volume - 1), Jain Brothers.
- Manoj Kumar Ghoshal and Dhirendra Kumar Das. 2008. Farm Power, Kalyani Publishers.

- Surendra Singh. 2007. Farm Machinery Principles and Applications. ICAR Publications.
- Roth/Field. 1992. Introduction to Agricultural Engineering - Problem Solving Approaches, 2nd. Edition. CBS publishers & distributors Pvt. Ltd.
- Surendra Singh & Verma. 2009. Farm Machinery Maintenance & Management. ICAR Publication.
- M.M. Pandey & Others. 2012. Handbook of Agricultural Engineering. ICAR publication
- Jagadishwar Sahay.1992. Elements of Agricultural Engineering. Agro Book Agency,Patna.
- Michal AM and Ojha TP.1993.VolI. Principles of Agricultural Engineering. Jain Brothers,New Delhi.
- Kepner R A Roy Bainer and Barger BL.1978. Principles of Farm Machinery. CBS Publisher and Distributors, Delhi.
- Jain S C. 2003. Farm Machinery-An approach. Standard Publishers and Distributors, New Delhi.
- Nakra, C.P.1986. Farm Machinery and Equipment. Dhanpat Rai and Sons, New Delhi.
- Klenin, N.I.Popov, I.F.and Sakun,V.A.1985. Agricultural Machines. Amerind publishing Co. Pvt. Ltd., New Delhi.

30. AGR – 122 (Water Management in Horticultural Crops)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Importance of water.
2.	Water resources in India.
3.	Area of different crops under irrigation.
4.	Function of water for plant growth.
5.	Effect of moisture stress on crop growth.
6.	Available and unavailable soil moisture, distribution of soil moisture
7.	Water budgeting, rooting characteristics – moisture extraction pattern.
8.	Water requirement of horticultural crops, lysimeter studies.
9.	Plant water potential climatological approach.
10.	Use of pan evaporimeter.
11.	Factor for crop growth stages, Critical stages of crop growth for irrigation.
12.	Irrigation scheduling – different approaches.
13.	Methods of irrigation – surface and sub-surface pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation.
14.	Economic use of irrigation water, water management problem,
15.	Soils quality of irrigation water, irrigation management practices for different soils and crops.
16.	Layout of different irrigation systems, drip, sprinkler, layout of underground pipeline system.

Topics in Practical:

S. No.	Topics
1.	Measurements of irrigation water by using water measuring devices.
2.	Use of common formula in irrigation practices.
3.	Practicing of land levelling and land shaping implements.
4.	Layout for different methods of irrigation.
5.	Estimation of soil moisture contents and soil moisture by using different methods and instruments.
6.	Scheduling of irrigation- different approaches, practicing use of instruments.
7.	Estimation of irrigation efficiency and water requirements of horticultural crops.
8.	Irrigation planning and scheduling.
9.	Soil moisture conservation practices.

Suggested Readings:

- Rao, Y.P. and Bhaskar, S.R. 2008. Irrigation Technology.
- Dilip Kumar Majumdar. 2004. Irrigation Water Management: Principles and Practices. Prentice Hall of India Pvt. Ltd.,
- S.V. Patil & Rajakumar, G. R., 2016. Water Management in Agriculture and Horticultural Crops.
- Satish serial publishing House, Delhi.
- Carr M. K. V. and Elias Fereres. 2012. Advances in Irrigation Agronomy. Cambridge University Press.
- Michael, A.M. 2015. Irrigation Theory and Practices. Vikas publishing house Pvt., Ltd.

31. AGR – 313 (Introduction to Major Field Crops)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Classification of crops.
2.	Distribution of field crops.
3.	Definitions and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping,
4.	Cultural practices for raising major cereals (rice, wheat, maize, barley)
5.	Cultural practices for raising major pulses (pigeonpea, chickpea, urid, moong linneed etc.)
6.	Cultural practices for raising major oil seeds (soybean, mustard, groundnut etc.)
7.	Cultural practices for raising major fodder crops (berseem, lucern etc.)
8.	Green manuring and crop rotation.

Topics in Practical:

S. No.	Topics
1.	Identification of crop plants
2.	Identification of Seeds of crops
3.	Identification of weeds
4.	Preparation of cropping scheme
5.	Application of herbicides in field crops.

Suggested Readings:

- 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 - Foodgrain 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.
- UAS, Bangalore. 2011. Package of Practice. UAS, Bangalore.
- 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.

32. AGR – 124 (Organic Farming)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Introduction and concept of organic farming.
2.	Relevance in present context .
3.	Organic production requirements.
4.	Biological intensive nutrient management-organic manures, vermicomposting, green manuring.
5.	Recycling of organic residues.
6.	Biofertilizers; Soil improvement and amendments.

7.	Integrated diseases and pest management–use of biocontrol agents, biopesticides pheromones, trap crops, bird perches.
8.	Weed management.
9.	Quality considerations, certification, labeling and accreditation processors, marketing and exports.

Topics in Practical:

S. No.	Topics
1.	Raising of vegetable crops organically through nutrient, diseases and pest management.
2.	Vermicomposting.
3.	Vegetable and ornamental nursery raising.
4.	Macro quality analysis, grading, packaging, postharvest management.

Suggested Readings:

- A.K. Dahama. 2007. Organic farming for sustainable agriculture. Agrobios (India), Jodhpur.
- Arun. K. Sharma. 2011. Handbook of Organic farming. Agrobios (India), Jodhpur.
- Joshi, Mukund 2016. New Vistas of Organic Farming. Scientific Publishers
- 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.
- Purshit, S.S. 2006. Trendsin Organic Farming in India. Agros Bios (INDIA), Jodhpur.
- Thampan, P. K. 1995. Organic Agriculture. Peckay tree Crops Development Foundation, Cochin, Kerala.
- Sathe, T.V.2004. Vermiculture and Organic Farming. Days Publishing House, New Delhi

Department – Plant Protection

33. PPT – 211 (Fundamentals of Plant Pathology)

Credit Hours: 1 (1+0)

Topics in Theory:

S. No.	Topics
1.	Introduction to the science of phytopathology, its objectives, scope and historical background.
2.	Classification of plant diseases, symptoms, signs, and related terminology.
3.	Parasitic causes of plant diseases
4.	Fungi, their characteristics and classification.
5.	Bacteria, their characteristics and classification.
6.	Viruses their characteristics and classification.
7.	Phytoplasma general characteristics and Cell structures.
8.	Protozoa their characteristics and classification.
9.	Algae their characteristics and classification.
10.	Flowering parasitic plants their characteristics and classification.
11.	Non-parasitic causes of plant diseases.
12.	Infection process.
13.	Survival and dispersal of plant pathogens.
14.	Plant disease epidemiology, forecasting and disease assessment
15.	Principles and methods of plant disease management
16.	Integrated plant disease management.
17.	Fungicides classification based on chemical nature, commonly used fungicides, bactericides and nematicides

Topics in Practical:

S. No.	Topics
1.	Familiarity with general plant pathological laboratory and field equipments
2.	Study of disease symptoms and signs.
3.	Study of host parasite relationship.
4.	Identification and isolation of plant pathogens.
5.	Koch's postulates.
6.	Preparation of fungicidal solutions, slurries, pastes and their applications

Suggested Readings:

- N.G. Ravichandra, 2013.Fundamentals of Plant Pathology. PHI Hall of India, New Delhi
- R.S. Mehrohtra, Ashok Agarwal. Fundamental of Plant Pathology

Agrotech publication Academy

- S.L. Godara, BBS Kapoor, B.S. Rathore. Disease management of spice crops-, Madhu Publications
- L. Darwin Christdhar Henry and H. Lewin Devasahayam Crop diseases: Identification, Treatment and Management. An Illustrated Handbook –, New India publishing Agency
- Singh, R.S. 1994. Diseases of Vegetable Crops. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
- Singh, R.S 1996. Plant Diseases. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
- Sohi, H.S. 1992. Diseases of Ornamental plants in India. ICAR, New Delhi
- Ranga Swamy, G. 1988. Diseases of Crop Plants in India. Prentice Hall of India Pvt. Ltd., New Delhi.
- Saha, L.R. 2002. Hand Book of Plant Diseases. Kalyani Publishers
- Arjunan, G. Karthikeyan, G. Dinakaran, D. Raguchander, T. 1999. Diseases of Horticultural Crops. Dept. of Plant Pathology, Tamilnadu Agricultural University Coimbatore.

36. NEM – 211 (Nematode Pests of Horticultural Crops and Their Management)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	History of development of nematology - definition, economic importance.
2.	General characters of plant parasitic nematodes, their morphology,
3.	Taxonomy, classification of Plant parasitic nematodes
4.	Biology and symptomatology of plant Parasitic nematode
5.	Control of important plant parasitic nematodes of fruits (tropical, subtropical and temperate) crops
6.	Control of important plant parasitic nematodes of Vegetable and tuber crops.
7.	Control of important plant parasitic nematodes of ornamental crops
8.	Control of important plant parasitic nematodes of spice and plantation crops.
9.	Role of nematodes in plant disease complex.
10.	Integrated nematode management

Topics in Practical:

S. No.	Topics
1.	Methods of sampling and extraction of nematodes from soil and plant parts,
2.	Killing, fixing and preparation of temporary and permanent nematode mounts.
3.	Nematicides and their use.
4.	Collection and preservation of 20 plant species/parts damaged by plant parasitic nematodes.

Suggested Readings:

- Upadhyay, K.D and Dwivedi, K. 1997. A text book of plant nematology. Amman Publishing House Aman publishing house, Meerut
- Vasanth Raju David, B. 2001. Elements of economic entomology. Popular book Depot, Chennai.
- Gopal Swaroop and Das Gupta 1986.ICAR, New Delhi. Plant Parasitic Nematodes of India Problems and Progress.
- Nair, M.R.G.K. 1975. Insects and Mites of Crops in India. ICAR, New Delhi
- Metcalf, R.L and Luckman, W.H. 1982. Introduction to Insect pest management Wiley Inter Science Publishing, New York.
- Butani, D.K. 1984. Insects and Fruits. Periodical Expert Book Agency, New Delhi
- E.I. Jonathan, I. Cannayane, K. Devrajan, S. Kumar, S. Ramakrishan, Agricultural Nematology. TNAU, Coimbatore.
- Plant Disease Control by Y.L. Nene 2018. 4th edition

37. ENT – 211 (Fundamentals of Entomology)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Introduction to phylum arthropoda
2.	Importance of class Insecta
3.	Insect dominance
4.	History of entomology in India
5.	Importance of entomology in different fields
6.	Definition, division and scope of entomology
7.	Comparative account of external morphology-types of mouth parts
8.	Types of antennae
9.	Types of legs
10.	Wings-Hypothetical wing venation and modification
11.	Genitalia
12.	Structure and function of cuticle
13.	Moulting and body segmentation
14.	Anatomy of digestive systems
15.	Circulatory systems
16.	Sensory organs
17.	Respiratory system
18.	Glandular systems
19.	Excretory systems
20.	Nervous systems

21.	Reproductive systems
22.	Types of reproduction
23.	Postembryonic development-eclosion
24.	Matamorphosis
25.	Types of egg larvae
26.	Types of Pupa
27.	Classification of insects up to orders sub-order and families of economic importance and their distinguished characters
28.	Plant mites – morphological features, important families with examples.

Topics in Practical:

S. No.	Topics
1.	Insect collection and preservation
2.	Identification of important insects
3.	General body organization of insects
4.	Study on morphology of grasshopper or cockroach
5.	Preparation of permanent mounts of mouth parts
6.	Preparation of permanent mounts of antennae
7.	Preparation of permanent mounts of legs
8.	Preparation of permanent mounts of wings
9.	Dissection of grasshopper for study of internal morphology
10.	Dissection of caterpillar for study of internal morphology
11.	Observations on metamorphosis of larvae
12.	Observations on metamorphosis of pupae
13.	Dissection of cockroaches.

Suggested Readings:

- Awasthi, V.B. 1997. Introduction to general and applied entomology. Scientific Publishers, Jodhpur, 379 p.
- Borror, D.J., C.A. Triple Horn and N.F. Johnson. 1987. An introduction to the study of insects (VI Edition). Harcourt Brace College Publishers, New York, 875p.
- Chapman, R.F. 1981. The Insects: Structure and function. Edward Arnold (Publishers) Ltd, London, 919p.
- Gullan, P.J. and Cranston, P.S. 2001. The insects- An outline of entomology, II edition, Chapman & Hall, Madras, 491p.
- Mani, M.S. 1968. General entomology. Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 912p.
- Nayar, K.K., T.N. Ananthakrishnan and B.V. David. 1976. General and applied entomology, Tata McGraw Hill Publishing Company Limited, New Delhi, 589p.

Department – Post Harvest Technology

41. PHM – 211 (Fundamentals of Food Technology)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Food and its function, physico-chemical properties of foods
2.	Food preparation techniques, nutrition, relation of nutrition of good health.
3.	Characteristics of well and malnourished population.
4.	Energy, definition, determination of energy requirements, food energy, total energy needs of the body.
5.	Mineral nutrition: macro minerals, function, utilization, requirements, sources, effects of deficiency.
6.	Micro-minerals (Ca, Fe and P) function, utilization, requirements, sources, effects of deficiency
7.	Vitamins: functions, sources, effects of deficiency, requirements of water soluble and fat-soluble vitamins.
8.	Balanced diet: recommended dietary allowances for various age groups.
9.	Assessment of nutritional status of the population.

Topics in Practical:

S. No.	Topics
1.	Methods of measuring food ingredients.
2.	Effect of cooking on volume and weight, determination of percentage of edible portion.
3.	Browning reactions of fruits and vegetables.
4.	Microscopic examination of starches.
5.	Estimation of energy, value proteins and fats of foods.
6.	Planning diet for various age groups.

Suggested Readings:

- Dr. Swaminathan, M.1985. Food and Nutrition Vol. I & II. BAPPCO, Bangalore.
- Dr. Swaminathan, M. 1985. Essential of Food and Nutrition Vol. II. BAPPCO, Bangalore.
- Manoranjan, K. and Sangita, S. 1996. Food Preservation and Processing. Kalyani Publishers 978-81-272-4262-6.
- Srilakshmi. 2010. Food Science. New age International 978-81-224-2724-0.
- Srilakshmi. 2005. Dietetics. New age International 978-81-224-1611-4.
- Shankunthala, M. 1972. Foods-Facts, Principles & Procedure. The Eastern Press, Bengaluru.
- Passmore, R. and Eastwood, M. A. 1986. Human Nutrition & Dietetics. ELBS.
- Anita, T. 1996. Food and Nutrition. Oxford 0198327668.

- Devendra, K. B. and Priyanka, T. 2006. An Introduction to Food Science and technology and Quality Management. Kalyani Publishers 81-272-2521-5.
- Monoranjam, K. and Sangita, S. 2008. Food Preservation and Processing. Kalyani Publishers 978-81-272-4262-6.
- George, I. S. and Dennis, D. L. 1994. Chemistry for the Health Science. MacMillan 0-02-405161-6.
- Masferton and Hurley. 1989. Chemistry Principles and Reactions. Saunders Golden Sunburst 0-03-005889-9.
- Bettelheim and March. 1984. Introduction to General, Organic & Biochemistry. Harcourt Brace college Puplishers 0030202175 Sounders college Puplishing.
- Gopalan, G., Ramasastri, B.V. and Balasubramnian, S. C. 1989. Nutritive valve of the Indian Foods. National Institute of Nutrition, ICMR, Hyderabad.
- http://www.fao.org/infoods/ y Swaminathan, M. 1988. Hand book of Food Science & Experimental Foods. Bappco publishers, Bangalore.
- Manay, S.N, Shadaksharaswamy, M.1998. Food-facts & Principles New Age International Publishers, New Delhi.
- Srilakshmi, B. 1995. Food Science. New Age International Publishers, New Delhi.

42. PHM – 322 (Post Harvest Management of Horticultural Crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Importance of Postharvest Technology of horticultural crops.
2.	Maturity indices, harvesting, handling of horticultural crops.
3.	Grading of fruits vegetables, cut flowers.
4.	Grading in Plantation crops, spices, medicinal and aromatic plants.
5.	Pre-harvest factors affecting quality of horticultural crops.
6.	Factors responsible for deterioration of horticultural produces.
7.	Physiological and bio-chemical changes in horticultural crops.
8.	Hardening and delaying ripening process in Horticulture produce.
9.	Postharvest treatments of horticultural crops.
10.	Quality parameters and specifications of Horticulture produce.
11.	Structure of fruits, vegetables and cut flowers related to physiological changes after harvest.
12.	Methods of storage for local and Export market.
13.	Pre-harvest treatments and pre-cooling in horticultural produce.
14.	Pre-storage and storage of horticultural produce.
15.	Different systems of storage of horticultural produce.
16.	Packaging methods and types of packages used in Horti. Industries

17.	Recent advances in packaging.
18.	Types of containers and cushioning materials used horticultural items.
19.	Vaccum packaging in horticultural produces.
20.	Cold storage, poly shrink packaging in horticultural produces.
21.	Grape guard packing treatments.
22.	Modes of transport

Topics in Practical:	
S. No.	**Topics**
1.	Practice in judging the maturity of various horticultural produce.
2.	Determination of physiological loss in weight in horticultural crops.
3.	Determination of quality and its loss in horticultural crops.
4.	Grading of horticultural produce.
5.	Post-harvest treatment of horticultural crops.
6.	Physical and chemical methods used for quality improvement in horticultural crops.
7.	Packaging in horticultural commodities.
8.	Storage and its types used for horticultural commodities.
9.	Post-harvest disorders in horticultural produce.
10.	Identification of storage pest and disease in spices
11.	Visit to markets Packing houses and cold storage units
12.	Practice in judging the maturity of various horticultural produce.
13.	Determination of physiological loss in weight in horticultural crops.
14.	Determination of quality and its loss in horticultural crops.

Suggested Readings:

- Verma, L. R. and Joshi, V. K. 2000. Post Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi
- Wiils, McGlasson and Graham, J. 2007. Post Harvest- An Introduction to the Physiology and Handling of Fruits, Vegetables and ornamentals. Cab International
- Stanley, J. K. 1998. Post Harvest Physiology of Perishable Plant Products. CBS, New Delhi.
- Neetu Sharma and Mashkoor Alam,
- Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi.
- Hulme, A.C. 1970. Food Science & Technology - A Series of Monograph. The Biochemistry of Fruits and their Products. Vol.-1. Academic Press London & New York.
- Mitra, S. K. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CAB International.
- Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.
- Thomposon, A. K. 1996. Post harvest Technology of Fruits and Vegetables. Blackwell Science.

43. PHM – 323 (Processing of Horticultural Crops)

Credit Hours: 3 (1+2)

Topics in Theory:

S. No.	Topics
1.	Importance and scope of fruit and vegetable preservation industry in India
2.	Food pipe line: Losses in post-harvest operations, unit operations in food processing.
3.	Principles and guidelines for the location and establishment of processing units in India
4.	Principles and methods of preservation by heat- pasteurization, Canning of fruits and vegetables
5.	Methods of preparation of Juices, RTS, Nectar, Squashes, Cordials, Syrups
6.	Fermented beverages
7.	Methods of preparation of Jam, Jelly and Marmalade
8.	Preservation by using sugar and chemical preservatives
9.	Methods of preparation of candies, preserves, crystallized fruits
10.	Preservation with salt and vinegar
11.	Methods of preparation of pickles
12.	Methods of preparation of Chutneys and Sauces
13.	Methods of preparation of Tomato and mushrooms products
14.	Freezing preservation
15.	Processing of plantation crops and their products
16.	Spoilage in processed fruits and vegetables
17.	Quality control of processed products
18.	Govt. policy on import and export of processed fruit products
19.	Food laws.

Topics in Practical:

S. No.	Topics
1.	Equipments used in food processing units
2.	Physico-chemical analysis of fruits and vegetables
3.	Canning of fruits and vegetables
4.	Preparation of RTS, nectar, squash, cordial, syrup
5.	Preparation of jam, jelly, marmalade
6.	Preparation of fruit chutneys, sauces, pickles (hot and sweet)
7.	Preparation of candies and preserves
8.	Dehydration of fruits and vegetables, tomato product dehydration
9.	Refrigeration and freezing of fruit and vegetables
10.	Processing of plantation crops

11.	Cut-out analysis of processed foods
12.	Visit to processing units

Suggested Readings:

- Verma, L. R. and Joshi, V. K. 2000. Post Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi.
- Dauthy, M. E. 1995. Fruits and Vegetables Processing- FAO Bulletin 119. International Book Distributing Co., Lucknow.
- Srivastava, R. P. & Sanjeev Kumar. 2002. Fruits and vegetable Preservation – Principles and Practice. International Book Distributing Co., Lucknow.
- Salunkhe, D.K., Bolin, H. R. and Reddy, N. R. 1991. Storage, Processing and Nutritional Quality of Fruits and Vegetables. 2nd Edition. Vol. II. CRC Press
- Neetu Sharma and Mashkoor Alam, M. 1998. Post Harvest Disease of Horticultural Perishable. International Book Distributing Co., Lucknow
- Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi
- Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.
- Manoranjan, K and Sangita, S. 1996. Food Preservation & Processing. Kalyani Publishers, India.
- Vijay, K. 2001. Text Book of Food Sciences and Technology. ICAR, New Delhi.
- Siddappaa, G. S., Girdhari Lal and Tandon, G.L. 1998. Preservation of Fruits and Vegetables. ICAR, New Delhi
- FAO - Training Manual No.17/2. 2007. Prevention of post harvest food losses: Fruits, Vegetables and Root crops. Daya Publishing House, Delhi.
- Morris, T. N. 2006. Principles of Fruit Preservation. Biotech Books, Delhi.
- Khan, K. A., Goyal, M. R., and Kalne, A. A. 2018. Processing of Fruits and Vegetables: From Farm to Fork. In Book Series: Innovations in Agricultural and Biological Engineering, Apple Academic Press, USA.
- Srivastava,R. P.andSanjeevK.1998. Fruit and vegetable preservation principles practice. International Book Distributing Co.,Lucknow.
- Girdharilal, Siddappa, G. S. and Tandon, G. L.1998. Preservation of fruits and vegetables. ICAR, New Delhi.
- Dauthy and Mircea, E.1995. Fruit and vegetables processing. International Book Distribution Co, Lucknow.
- Kaysand Stanely,J. 1998. Postharvest physiology of perishable plant products. CBS Publishers, Distributors, New Delhi
- Bhatti, S 1995.Vame, Fruit and vegetable processing. CBS Publishers, Distributors, NewDelhi.

- Salunkhe, D.K., Bolin, H. R. and Reddy, N. R. 1991. Storage, Processing and Nutritional Quality of Fruits and Vegetables. 2nd Edition. Vol. II. CRC Press
- Neetu Sharma and Mashkoor Alam, M. 1998. Post Harvest Disease of Horticultural Perishable. International Book Distributing Co., Lucknow
- Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi
- Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.

Department – Vegetable Science

44. VSC – 121 (Tropical and Subtropical Vegetables Crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops.
2.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of tomato
3.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of brinjal
4.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of chilli
5.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing capsicum/Shimla Mirch
6.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of okra
7.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of Amaranthus,
8.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of cluster bean,

9.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of of cowpea.
10.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of lablab bean.
11.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of snap bean.
12.	General description about cucurbits. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, sowing, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of cucumber.
13.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of bitter gourd.
14.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting, sowing, spacing, planting systems, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of bottle gourd.
15.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of sponge gourd.
16.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of ridge gourd.
17.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, methods of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of watermelon

18.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, methods of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of muskmelon
19.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of summer squash,
20.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of winter squash
21.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of pumpkin
22.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, time of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of round melon
23.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, sowing, spacing, methods of sowing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of long melon
24.	Description of varieties and hybrid, climate and soil requirements, preparation of field, nursery practices, planting, spacing, time of planting, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of ivy gourd
25.	Description of varieties and hybrid, climate and soil requirements, preparation of field, nursery practices, planting, spacing, time of planting, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of pointed gourd,
26.	Description of varieties and hybrid, climate and soil requirements, preparation of field, nursery practices, planting, spacing, time of planting, methods of planting, staking, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of spine gourd
27.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation

	of field, method of propagation, nursery raising, planting, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of moringa
28.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, method of propagation, nursery raising, planting, spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of curry leaf
29.	Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; sowing, time of sowing, spacing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of portulaca
30.	Description of varieties, climate and soil requirements, preparation of field, sowing, seed rate, spacing, planting systems, staking, water and weed management, nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, post-harvest handling, storage, marketing and economics of cultivation of basella.
31.	Description of varieties, climate and soil requirements, seed rate, preparation of field, sowing, seed rate, spacing, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators, cropping systems, harvesting, yield, economics of cultivation, post-harvest handling, storage and marketing of sorrel and roselle

Topics in Practical:

S. No.	Topics
1.	Identification and description of tropical and sub-tropical vegetable crops
2.	Nursery practices and transplanting of tropical and sub-tropical vegetable crops
3.	Preparation of field for tropical and sub-tropical vegetable crops
4.	Sowing/planting for direct sown and planted tropical and sub-tropical vegetable crops
5.	Herbicide use in tropical and sub-tropical vegetable crops
6.	Top dressing of fertilizers in tropical and sub-tropical vegetable crops
7.	Intercultural operations in tropical and sub-tropical vegetable crops
8.	Use of growth regulators in tropical and sub-tropical vegetable crops
9.	Identification of nutrient deficiencies, physiological disorders in tropical and sub-tropical vegetable crops
10.	Harvest indices and maturity standards in tropical and sub-tropical vegetable crops
11.	Harvesting in tropical and sub-tropical vegetable crops
12.	Post-harvest handling, storage and marketing of tropical and sub-tropical vegetable crops
13.	Cost of cultivation for tropical and sub-tropical vegetable crops
14.	Project preparation for commercial cultivation of tropical and sub-tropical vegetables

Suggested Readings:

- S. Thamburaj, 2014. Text Book of Vegetable, Tuber crops and Spices. ICAR, New Delhi
- B.R. Choudhary, 2009. A text Book on Production Technology of Vegetables. Kalyani Publishers. Ludhiana.
- T.K. Bose, 2002.Vegetable Crops. Naya prakash. Kolkata
- T. R. Gopal Krishnan, 2007. Vegetable Crops. New India Publishing Agency. New Delhi.
- K.V. Kamath, 2007.Vegetable Crop Production. Oxford Book Company. Jaipur
- M.S. Dhaliwal, 2008. Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana
- Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt. Ltd .New Delhi.
- K S Yawalkar, 2008. Vegetable crops in India. Agri-Horticultural Pub. House. Nagpur. 2004
- M.K. Rana, 2008.Olericulture in India. Kalyani Publishers. Ludhiana
- P. Hazra, 2006.Vegetable Science. Kalyani Publishers. Ludhiana
- Pratibha Sharma, 2007.Vegetables: Disease Diagnosis and Biomanagement. Avishkar Publishers. Jaipur
- Nath Prem, 1994.Vegetables for the Tropical Regions. ICAR New Delhi
- K.L. Chadha, 1993. Advances in Horticulture. Malhotra publishing house. New Delhi
- Shanmugavelu, K.G., 1989. Production Technology of Vegetable Crops. Oxford &IBH Publishing Co. Pvt. Ltd, New Delhi.
- Choudhury, B. (ICAR). 1990. Vegetables. 8th edition, National Book Trust, New Delhi.
- Singh, D.K., 2007. Modern Vegetable varieties and production. IBN publishers, Technology International Book Distributing Co, Lucknow.
- Singh, S.P. 1989. Production Technology of Vegetable Crops. ARCC, Sadar Karnal
- Chadha, K.L. 2001. Hand Book of Horticulture. ICAR, New Delhi
- Hazra, P.; Chattopadhyay, A.; Karmakar, K. and Dutta S. 2011. Modern Technology in Vegetable Production. NIPA, New Delhi
- Mourya, K.R. 2012. “Bharat Ki Salad Phasalen” Satish Serial Publishing House, Azadpur, Delhi.
- Nath, Prem and Swamy, KRM. 2016. Text Book of Vegetable Crops. ICAR, New Delhi

45. VSC – 212 (Temperate Vegetable Crops)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Importance of temperate vegetable crops in nutrition and national economy
2.	Cabbage and Chinese cabbage: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
3.	Cauliflower: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing

4.	Knol khol: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
5.	Sprouting broccoli and Brussels' sprout: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
6.	Lettuce and Vegetable kale: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
7.	Spinach and Palak: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and Marketing
8.	Garlic: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
9.	Onion: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
10.	Leek: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
11.	Radish: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
12.	Carrot: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
13.	Turnip and Beet root: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
14.	Peas: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
15.	Broad bean: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
16.	Rhubarb: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
17.	Asparagus: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing
18.	Globe artichoke: Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing

Topics in Practical:

S. No.	Topics
1.	Identification and description of varieties/hybrids of cole crops
2.	Identification and description of varieties/hybrids of root crops
3.	Identification and description of varieties/hybrids of temperate , leafy and other vegetable crops
4.	Propagation method of temperate vegetable crops

5.	Nursery management temperate vegetable crops
6.	Preparation of field for sowing/planting temperate vegetable crops
7.	Sowing/transplanting practice
8.	Identification of physiological and nutritional disorders and their corrections
9.	Post-harvest handling of temperate vegetable crops
10.	Cost of cultivation of temperate vegetable crops
11.	Field visits to commercial farms

Suggested Readings:

- S. Thamburaj. 2014. Text Book of Vegetable, Tuber crops and Spices. ICAR, New Delhi.
- B.R. Choudhary 2009.AText Book on Production Technology of Vegetables. Kalyani Publishers. Ludhiana.
- T.K.Bose. 2002.Vegetable Crops. Nayaprakash. Kolkata
- P. Hazra. 2011. Modern Technology in Vegetable Production. New India Publishing Agency.
- New Delhi.
- T.R.Gopal Krishnan, 2007. Vegetable Crops. New India Publishing Agency. New Delhi.
- K.V.Kamath. 2007.Vegetable Crop Production. Oxford Book Company. Jaipur
- M.S.Dhaliwal, 2008.Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana
- Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.
- K S Yawalkar, 2004.Vegetable crops in India. Agri-Horticultural Pub. House. Nagpur.
- M.K. Rana, 2008.Olericulture in India. Kalyani Publishers. Ludhiana
- P. Hazra. 2006.Vegetable Science. Kalyani Publishers .Ludhiana
- Pratibha Sharma, 2007.Vegetables: Disease Diagnosis and Biomanagement. Avishkar
- Publishers. Jaipur
- Uma Shankar. 2008. Vegetable Pest Management Guide for Farmers. International Book Distribution Co. Publication. Lucknow.
- Nath Prem. 1994.Vegetables for the Tropical Regions. ICAR New Delhi
- K.L. Chadha. 1993.Advances in Horticulture. Malhotra publishing house. New Delhi
- Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash,
- Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.
- Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.

46. VSC – 223 (Precision Farming and Protected Cultivation)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics

1.	Precision farming – concept of precision farming, importance and need, principles,
2.	Laser leveling,
3.	Mechanized direct seed sowing
4.	Seedling and sapling transplanting
5.	Mapping of soils and plant attributes
6.	Site specific input application
7.	Weed management
8.	Insect pests and disease management
9.	Yield mapping in horticultural crops
10.	Introduction of Green house technology
11.	Types of Green Houses
12.	Plant response to Greenhouse environment
13.	Planning and design of greenhouses
14.	Design criteria of greenhouse for cooling and heating purposes
15.	Green house equipments
16.	Material of construction for traditional and low-cost green houses
17.	Irrigation systems used in greenhouses
18.	Typical applications, passive solar green house, hot air greenhouse heating systems,
19.	Green house drying
20.	Cost estimation and economic analysis
21.	Choice of crops for cultivation under greenhouses
22.	Problems/constraints of greenhouse cultivation and future strategies.
23.	Growing media, soil culture, type of soil required,
24.	Drainage, flooding and leaching,
25.	Soil pasteurization in peat moss and mixtures, rock wool and other inert media,
26.	Nutrient film technique (NFT)/hydroponics.

Topics in Practical:

S. No.	Topics
1.	Study of different types of greenhouses based on shape
2.	Study of different types of construction and cladding materials
3.	Calculation of air rate exchange in an active summer cooling system
4.	Estimation of drying rate of agricultural products inside green house
5.	Testing of soil to study its suitability for growing crops in greenhouses
6.	Testing of water to study its suitability for growing crops in greenhouses
7.	The study of fertigation requirements for greenhouses crops
8.	Estimation of E.C. in the fertigation solution

9.	The study of various growing media used in raising of greenhouse crops
10.	Preparation of various growing media used in raising of greenhouse crops and their pasteurization/sterilization
11.	Nursery raising of vegetable crops in protected structures
12.	Use of walk in tunnels and low tunnels for vegetable cultivation
13.	Visit to commercial green houses
14.	Economics of protected cultivation

Suggested Readings:

- 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.
- Reddy, P. Parvatha. 2011. Sustainable Crop Protection under Protected Cultivation. Springer Publications. USA.
- 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.
- Aldrich RA & Bartok JW. 1994. NRAES, Riley, Robb Hall. Green House Engineering. Cornell University, Ithaca, New York.
- Pant V Nelson. 1991. Green House Operation and Management. Bali Publ
- Srinivasan, Ancha (2006). Handbook of Precision Agriculture Principles and Applications, Taylor & Francis
- Zhang, Qin (2015). Precision Agriculture Technology for Crop Farming, CRC Press
- Krishna, K.R. (2016). Precision Farming Soil Fertility and Productivity Aspects, CRC Press
- Pedersen, Soren Marcus; Lind, Kim Martin (2017). Precision Agriculture: Technology and Economic Perspectives, Springer
- Tiwari, G.N. 2003. Greenhouse Technology for Controlled Environment. Narosa Publishing House, New Delhi.

47. VSC – 224 (Spices and Condiments)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	History, scope and importance, present status, area and production, uses, export potential and role of spices and condiments in national economy.
2.	Cardamom: Classification, soil and climate, propagation-seed, vegetative and micropropagation systems, sowing and methods of planting, varieties, nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation.
3.	Pepper: Classification, soil and climate, propagation-seed, vegetative and micro propagation systems, sowing and methods of planting, varieties, nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation.
4.	Betel vine: Classification, soil and climate, propagation-seed, vegetative and micro propagation systems, sowing and methods of planting, varieties, nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation.
5.	Ginger: Classification, soil and climate, propagation-seed, vegetative and micro propagation systems and methods of planting, varieties, nutritional management, irrigation practices, weeds control, mulching, earthing-up and cover cropping. Role of growth regulators, shade crops and shade regulation.
6.	Turmeric: Classification, soil, climate and varieties, propagation-seed, vegetative and micro propagation systems and methods of planting sowing spacing. Nutritional management, irrigation practices, weed control, mulching, earthing-up and cover cropping. Role of growth regulators, shade crops and shade regulation.
7.	Clove: Soil, climate and varieties, propagation-seed, vegetative and micro propagation systems and methods of planting, sowing spacing. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation.
8.	Nutmeg: Classification, soil, climate varieties, propagation-seed, vegetative and micro propagation systems and methods of planting, sowing spacing. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation.
9.	Cinnamon: Classification, soil and climate varieties, propagation-seed, vegetative and methods of planting spacing and sowing. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation.
10.	All spice: Classification, soil and climate varieties, propagation-seed, vegetative and micro propagation systems and methods of planting. Nutritional management, irrigation practices, weeds control, mulching. Training and pruning practices, role of growth regulators, shade crops and shade regulation.
11.	Curry leaf: soil and climate, varieties, propagation-seed and vegetative and methods of planting. Nutritional management, irrigation practices, weeds control, mulching.

	Training and pruning practices, role of growth regulators.
12.	Coriander: Soil, climate and varieties, seed sowing , spacing. Nutritional management, irrigation practices, weeds control, mulching and cover cropping. Role of growth regulators, shade crops and shade regulation.
13.	Fenugreek: Soil, climate and varieties, seed sowing , spacing. Nutritional management, irrigation practices, weeds control, mulching and cover cropping. Role of growth regulators, shade crops and shade regulation.
14.	Fennel: Soil, climate and varieties, seed sowing , spacing. Nutritional management, irrigation practices, weeds control, mulching and cover cropping. Role of growth regulators, shade crops and shade regulation.
15.	Cumin: Soil, climate and varieties, seed sowing , spacing. Nutritional management, irrigation practices, weeds control, mulching and cover cropping. Role of growth regulators, shade crops and shade regulation.
16.	Dill: Soil, climate and varieties, seed sowing , spacing. Nutritional management, irrigation practices, weeds control, mulching and cover cropping. Role of growth regulators, shade crops and shade regulation.
17.	Celery: Soil, climate and varieties, seed sowing , spacing. Nutritional management, irrigation practices, weeds control, mulching and cover cropping. Role of growth regulators, shade crops and shade regulation.
18.	Bishops weed: Soil, climate and varieties, seed sowing , spacing. Nutritional management, irrigation practices, weeds control, mulching and cover cropping. Role of growth regulators, shade crops and shade regulation.
19.	Saffron: Soil and climate varieties, propagation-seed, vegetative and micro propagation systems and methods of planting and spacing. Nutritional management, irrigation practices, weeds control, mulching and harvesting
20.	Vanilla: Soil and climate varieties, propagation-seed, vegetative and micro propagation systems and methods of planting sowing and spacing. Nutritional management, irrigation practices, weed control, mulching. Role of growth regulators.
21.	Thyme: Soil and climate varieties, propagation and methods of planting, and spacing. Nutritional management, irrigation practices, weeds control, mulching. Role of growth regulators.
22.	Rosemary: Soil and climate varieties, propagation and methods of planting and spacing. Nutritional management, irrigation practices, weeds control, mulching and cover cropping. Role of growth regulators.
23.	Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction of essential oil and oleoresins of Crops: Cardamom, Pepper, Betel vine, Ginger, Turmeric, Clove, Nutmeg, Cinnamon, All spice, Curry leaf, Coriander, Fenugreek, Fennel, Cumin, Dill, Celery, Bishops weed, Saffron, Vanilla, Thyme and Rosemary.
24.	Economics of cultivation, role of Spice Board and Pepper. Export Promotion Council, Institutions and Research Centers in R&D of Crops: Cardamom, Pepper, Betel Vine, Ginger, Turmeric, Clove, Nutmeg, Cinnamon, All Spice, Curry Leaf, Coriander, Fenugreek, Fennel, Cumin, Dill, Celery, Bishops Weed, Saffron, Vanilla, Thyme and Rosemary.

Topics in Practical:

S. No.	Topics
1.	Identification of varieties of spices and condiments.
2.	Propagation, seed treatment of spices and condiments.
3.	Sowing; layout, planting; hoeing and earthing up, manuring of spices and condiments.
4.	Use of weedicides, training and pruning in different spices and condiments.
5.	Maturity standards, harvesting, curing, processing, grading in spices and condiments.
6.	Extraction of essential oils and oleoresins form different spices and condiments.
7.	Visit to commercial plantations of spices and condiments.

Suggested Readings:

- Shanmugavelu, K.G. Kumar, N and Peter, K.V., 2005. Production technology of spices and plantation crops. . Agrosis, Jodhpur
- Shanmugavelu, K.G. and Madhava Rao, 1977. Spices and Plantation Crops. Madras Popular Book Depot.
- Kumar, N. J.B. M. Md. Abdul Khaddar, Ranga Swamy, P. and Irulappan, I., 1997. Introduction to Spices, Plantation Crops, and aromatic crops. Oxford & IBH, New Delhi.
- Pruthi, J.S., 1980. Spices and Condiments. Academic Press, New York.
- Pruthi, J.S., 1993. Major Spices of India- Crop Management Postharvest Technology. ICAR, New Delhi.
- Pruthi, J.S., 2001. Minor Spices and Condiments-Crop Management Post Harvest Technology. ICAR, New Delhi.
- Purseglove, Brown, E.G. Green, G.Z. Robbins, S.R.J. London, Longman, 1981. Spices Vol.I & II.

48. VSC – 315 (Breeding of Vegetable, Tuber and Spice Crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Breeding objectives and important concepts of breeding, self-pollinated, cross pollinated and vegetative propagated crops
2.	Plant genetic resources, their conservation and utilization in crop improvement
3.	Breeding for insect resistance,
4.	Breeding for disease resistance
5.	Breeding for abiotic resistance
6.	Male sterility and self-incompatibility and their utilization in development of hybrids
7.	Origin, distribution of species, wild relatives and forms of Tomato
8.	Origin, distribution of species, wild relatives and forms of brinjal

9.	Origin, distribution of species, wild relatives and forms of Capsicum, Chilli
10.	Origin, distribution of species, wild relatives and forms of Cucurbits
11.	Origin, distribution of species, wild relatives and forms of Bhendi/okra
12.	Origin, distribution of species, wild relatives and forms of Cabbage and Cauliflower
13.	Origin, distribution of species, wild relatives and forms of tuber crops Potato sweet potato and cassava
14.	Origin, distribution of species, wild relatives and forms of Carrot, Radish
15.	Origin, distribution of species, wild relatives and forms of Spice crops Ginger, Turmeric and seed spices
16.	Breeding procedures for development of hybrids/varieties in various crops
17.	Genetic basis of adoptability and stability

Topics in Practical:

S. No.	Topics
1.	Floral biology and pollination mechanism in self and cross pollinated vegetables, tuber crops and spices,
2.	Working out phenotypic and genotypic heritability, genetic advance. GCA, SCA, combining ability, heterosis, heterobeltosis, standard heterosis, GxE interactions (stability analysis)
3.	Preparation and uses of chemical and physical mutagens.
4.	Polyploidy breeding and chromosomal studies.
5.	Techniques of F1 hybrid seed production
6.	Maintenance of breeding records

Suggested Readings:

- Hari Hara Ram, 2013.Vegetable Breeding: Principle and Practices**.** Kalyani Publishers.
- Ludhiana.
- Vishnu Swaroop, 2014. Vegetable Science &Technology in India. Kalyani Publishers.
- Ludhiana.
- Kallo.G, 1998. Vegetable Breeding (Vol. I to IV). CRC Press. Florida. 1988.
- H.P. Singh, 2009.Vegetable Varieties of India. Studium Press (India) Pvt Ltd. New Delhi.
- M.S. Dhaliwal. 2012. Techniques of Developing Hybrids in Vegetable Crops. Agrobios.
- Jodhpur.
- P.K.Singh, 2005. Hybrid Vegetable Development. CRC Press. Florida.
- M.S.Dhaliwal, 2009. Vegetable Seed Production & Hybrid Technology. Kalyani Publishers Ludhiana.

49. VSC – 316 (Potato and Tuber Crops)

Credit Hours: 2 (1+1)

Topics in Theory:

S. No.	Topics
1.	Origin, area, production, economic importance and export potential of potato and tropical, sub-tropical and temperate tuber crops
2.	Description of varieties, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of potato
3.	Description of varieties, climate and soil requirement, season; propagation; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of sweet potato
4.	Description of varieties, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of arrow root
5.	Description of varieties and hybrids, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of cassava
6.	Description of varieties and hybrids, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of xanthosoma
7.	Description of varieties, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of colocasia
8.	Description of varieties, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of amorphophallus
9.	Description of varieties and hybrids, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems,

	harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of dioscorea
10.	Description of varieties and hybrids, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of Jerusalem artichoke
11.	Description of varieties and hybrids, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of horse radish
12.	Description of varieties and hybrids, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of yam bean
13.	Description of varieties and hybrids, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of Chinese potato
14.	Description of varieties and hybrids, climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems, harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing of winged bean

Topics in Practical:

S. No.	Topics
1.	Identification and description of potato and tropical, sup-tropical and temperate tuber crops
2.	Propagation of tuber crops
3.	Planting systems in tuber crops
4.	Field preparation and sowing/planting of tuber crops
5.	Top dressing of fertilizers in tuber crops
6.	Intercultural operations in tuber crops
7.	Use of herbicides and growth regulators in potato and tuber crops
8.	Identification of nutrient deficiencies, physiological disorders
9.	Harvest indices and maturity standards in potato and tuber crops
10.	Post-harvest handling, storage and marketing of potato and tuber crops
11.	Seed/planting material collection of different tuber crops

12.	Working out cost of cultivation of tuber crops
13.	Project preparation of commercial cultivation

Suggested Readings:

- S. Thamburaj. 2014. Text Book of Vegetable, Tuber Crops and Spices. ICAR, New Delhi.
- B.R. Choudhary 2009.AText Book on Production Technology of Vegetables. Kalyani Publishers. Ludhiana.
- T.K. Bose. 2002.Vegetable Crops. Nayaprakash. Kolkata
- P. Hazra. 2011. Modern Technology in Vegetable Production. New India Publishing Agency. New Delhi.
- T.R. Gopal Krishnan, 2007. Vegetable Crops. New India Publishing Agency. New Delhi.
- K.V. Kamath. 2007.Vegetable Crop Production. Oxford Book Company. Jaipur
- M.S. Dhaliwal, 2008.Handbook of Vegetable Crops. Kalyani Publishers. Ludhiana
- Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.
- K S Yawalkar, 2004.Vegetable Crops in India. Agri-Horticultural Pub. House. Nagpur.
- M.K. Rana, 2008.Olericulture in India. Kalyani Publishers. Ludhiana
- P. Hazra. 2006.Vegetable Science. Kalyani Publishers .Ludhiana
- Pratibha Sharma, 2007.Vegetables: Disease Diagnosis and Biomanagement. Avishkar Publishers. Jaipur
- Nath Prem. 1994.Vegetables for the Tropical Regions. ICAR New Delhi
- K.L.Chadha. 1993.Advances in Horticulture. Malhotra Publishing House. New Delhi
- Shanmugavelu, K.G. 1989. Production Technology of Vegetable Crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.
- Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.
- Choudhary, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.
- Vincent Lebot, 2008.Tropical Roots and Tuber Crops. CAVI.
- J.E. Bradashaw, 2010. Root and Tuber Crops. Springer Publications.

50. VSC – 327 (Seed Production of Vegetable, Tuber and Spice Crops)

Credit Hours: 3 (2+1)

Topics in Theory:

S. No.	Topics
1.	Introduction and history of seed industry in India
2.	Definition of seed, Classes-types of seed, differences between grain and seed
3.	Importance and scope of vegetable seed production in India
4.	Principles of vegetable seed production
5.	Factors affecting quality seed production, role of temperature, humidity and light in

	vegetable seed production
6.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of cole crops
7.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of root vegetables
8.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of solanaceous vegetables
9.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of cucurbits
10.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of okra
11.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of leafy vegetables and exotic vegetables
12.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of bulb crops
13.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of leguminous vegetables
14.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of spice crops like coriander, fennel and fenugreek etc.
15.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of tuber crops
16.	Land requirements, climate season, planting time, nursery management, seed rate, rouging, seed extraction and storage of exotic vegetables
17.	Seed production technology in turmeric and ginger
18.	Physiological and harvestable maturity for seed.
19.	Seed extraction and drying.
20.	Seed germination and Purity analysis.
21.	Field and seed standards.
22.	Seed legislation: seeds acts and rules.

Topics in Practical:

S. No.	Topics
1.	Studies of seed structure, colour, size, shape and texture
2.	Study on varietal characters, Identification of contaminants
3.	Field inspection of seed crops
4.	Harvesting and seed extraction: study of harvest indices, fruit grading and seed extraction techniques
5.	Seed sampling equipments, mixing and dividing methods
6.	Estimation of moisture

7.	Purity analysis – equipments used – reporting results
8.	Seed germination testing
9.	Tetrazolium test – evaluation
10.	Seed health test – testing and identification of pathogen /Insects
11.	Method of seed production in vegetable , tuber and spice crops
12.	Seed certification in vegetable , tuber and spice crops
13.	Seed processing machines
14.	Visit to seed production and processing units

NON-GRADIAL COURSES

Semester I

Course Title: National Service Scheme I 2(0+2)

- **Introduction and basic components of NSS:**
- **Orientation**: history, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health
- **NSS programmes and activities**
- Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary
- **Understanding youth**
- Definition, profile, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change
- **Community mobilisation**
- Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilisation involving youth-adult partnership
- **Social harmony and national integration**
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building
- **Volunteerism and shramdan**
- Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism
- **Citizenship, constitution and human rights**
- Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information
- **Family and society**
- Concept of family, community (PRIs and other community-based organisations) and society
- **Importance and role of youth leadership**
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership
- **Life competencies**
- Definition and importance of life competencies, problem-solving and decision-making, inter personal communication

- **Youth development programmes**
- Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organisations
- **Health, hygiene and sanitation**
- Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health.
- **Youth health, lifestyle, HIV AIDS and first aid**
- Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid
- **Youth and yoga**
- History, philosophy, concept, myths and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method
- **Vocational skill development**
- To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list
- **Issues related environment**
- Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservation) and waste management
- **Disaster management**
- Introduction and classification of disaster, rehabilitation and management after disaster; role of NSS volunteers in disaster management.
- **Entrepreneurship development**
- Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.
- **Formulation of production oriented project**
- Planning, implementation, management and impact assessment of project
- **Documentation and data reporting**
- Collection and analysis of data, documentation and dissemination of project reports
- **Youth and crime**
- Sociological and psychological factors influencing youth crime, cyber-crime, pear mentoring in preventing crime and awareness for juvenile justice
- **Civil/self defence**

- Civil defence services, aims and objectives of civil defence; needs and training of self-defence
- **Resource mobilisation**
- Writing a project proposal of self-fund units (SFUs) and its establishment
- **Additional life skills**
- Positive thinking, self-confidence and esteem, setting life goals and working to achieve them, management of stress including time management.

Semester I

Course Title : National Cadet Corps **2(0+2)**

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march and dressing.
- Saluting at the halt, getting on parade, dismissing and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear.
- Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march and halt.
- Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honours and awards
- Nation Building- cultural heritage, religions, traditions and customs of India. National integration.
- Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizen.
- Leadership traits, types of leadership. Character/personality development.
- Civil defence organization, types of emergencies, firefighting, protection,
- Maintenance of essential services, disaster management, aid during development projects. 15. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation.
- Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health.
- Adventure activities
- Basic principles of ecology, environmental conservation, pollution and its control.

- Precaution and general behaviour of girl cadets, prevention of untoward incidents, vulnerable parts of the body, self-defence.
- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms.
- Shoulder from the order and vice-versa, present from the order and vice-versa.
- Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice-versa.
- Guard mounting, guard of honour, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning and sight setting.
- Loading, cocking and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight.
- Theory of groups and snap shooting. Firing at moving targets. Miniature range firing.
- Characteristics of Carbine and LMG.
- Introduction to map, scales and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours and gradients. Cardinal points and finding north. Types of bearings and use of service protractor.
- Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map.
- Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defences obstacles, mines and mine lying. Bridging, watermanship
- Field water supplies, tracks and their construction.
- Nuclear, Chemical and Biological Warfare (NCBW)
- Judging distance. Description of ground and indication of landmarks.
- Recognition and description of target. Observation and concealment. Field signals. Section formations.
- Fire control orders. Fire and movement. Movement with/without arms. Section battle drill.
- Types of communication, media, latest trends and developments.

References

Cadet Hand Book (Army Wing)	Major R.C. Mishra
Cadet Hand Book (Army Wing)	Directorate General, NCC, Ministry of Defence, R.K. Puram, New Delhi

Semester I

Course Title: Physical Education and Yoga Practices 2(0+2)

- Teaching of skills of Football – demonstration, practice of the skills, correction, involvement in game situation with teaching of rules of the game (For girls teaching of Tennikoit)
- Teaching of skills of Basketball – demonstration, practice of the skills, correction of skills, involvement in game situation and teaching of rule of the game
- Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills, involvement in game situation with teaching of rules of the game
- Teaching of skills of Ball Badminton – demonstration, practice of the skills, correction of skills, involvement in game situation with teaching of rules of the game
- Teaching of some of Asanas – demonstration, practice and correction
- Teaching of skills of Table Tennis – demonstration, practice of skills, correction and practice and involvement in game situation with teaching of rule of the game
- Teaching – Meaning, Scope and importance of Physical Education
- Teaching – Definition, Type of Tournaments
- Teaching – Physical Fitness and Health Education
- Construction and laying out of the track and field (*The girls will have Tennikoit and Throw Ball).
- Teaching of skills of Hockey – demonstration practice of the skills and correction. And involvement of skills in games situation with teaching of rules of the game
- Teaching of skills of Kho-Kho – demonstration practice of the skills and correction. Involvement of the skills in games situation, with teaching of rules of the game
- Teaching of different track events – demonstration practice of the skills and correction with competition among them.
- Teaching of weight training – demonstration practice and correction.
- Teaching of circuit training – demonstration practice and correction.
- Teaching of calisthenics – demonstration practice and correction.

References

Foundation of Physical Education	C.A. Bucher and D.A. Wuest
Introduction to Physical Education, Fitness and Sports	Davyal
Applied Anatomy and Biomechanics in sports	John Bloom field et al.
Methods of Physical Education	Kamlesh and Sangral

Science of Sports training	Hardayal Singh
Application of Measurement to physical education	H. Harrigon Clark and David H. Clark

PROGRAMME (3-15)

M.Sc.

Agriculture & Horticulture

FSC 501 Tropical and Dry Land Fruit Production 2+1

Objective

To impart basic knowledge about the importance and management of tropical and dry land fruits grown in India.

Theory

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

Crops

UNIT I:	Mango and Banana
UNIT II:	Citrus and Papaya
UNIT III:	Guava, Sapota and Jackfruit
UNIT IV:	Pineapple, Annonas and Avocado
UNIT V:	Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics

Practical

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

Suggested Readings

Bose T.K., Mitra S.K. & Rathore D.S. (Eds.). 1988. Temperate Fruits - Horticulture. Allied Publ.

Bose T.K., Mitra SK & Sanyal D. 2001. (Eds.). Fruits -Tropical and Subtropical. Naya Udyog.

Chadha K.L. & Pareek O.P. 1996. (Eds.). Advances in Horticulture. Vols. III-V. Malhotra Publ. House.

Nakasone, H.Y. & Paul, R.E. 1998. Tropical Fruits. CABI.

Peter, K.V. 2008. (Ed.). Basics of Horticulture. New India Publ. Agency.

Pradeep kumar T., Suma B., Jyothibhaskar & Satheesan K.N. 2008. Management of Horticultural Crops. Parts I, II. New India Publ. Agency.

Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.

Singh H.P., Negi, J.P. & Samuel J.C. (Eds.). 2002. Approaches for Sustainable Development of Horticulture. National Horticultural Board.

Singh H.P., Singh, G, Samuel, J.C. & Pathak, R.K. (Eds.). 2003. Precision Farming in Horticulture. NCPAH, DAC/PFDC, CISH, Lucknow.

FSC 502 Subtropical and Temperate Fruit Production 2+1

Objective

To impart basic knowledge about the importance and management of subtropical and temperate fruits grown in India.

Theory

Commercial varieties of regional, national and international importance, eco-physiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of

flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.

Crops

UNIT I	:	Apple, pear, quince, grapes
UNIT II	:	Plums, peach, apricot, cherries, hazelnut
UNIT III	:	Litchi, loquat, persimmon, kiwifruit, strawberry
UNIT IV	:	Nuts- walnut, almond, pistachio, pecan
UNIT V	:	Minor fruits- mangosteen, carambola, bael, wood apple, fig, amun, rambutan, pomegranate

Practical

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

Suggested Readings

Bose, T.K., Mitra, S.K. & Sanyol, D. (Ed.). 2002. Fruits of India – Tropical and Sub-tropical. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha, K.L. & Pareek, O.P. 1996. (Eds.). Advances in Horticulture. Vol. I. Malhotra Publ. House.

Chadha, K.L. & Shikhamany, S.D. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.

Janick, J. & Moore, J.N. 1996. Fruit Breeding. Vols.I-III. John Wiley & Sons.

Nijjar, G.S. 1977. (Eds.). Fruit Breeding in India. Oxford & IBH.

Radha, T. & Mathew, L. 2007. Fruit Crops. New India Publ. Agency.

Singh, S., Shivankar, V.J., Srivastava, A.K. & Singh, I.P. (Eds.). 2004. Advances in Citriculture. Jagmander Book Agency.

FSC 503 Biodiversity and Conservation of Fruit Crops 2+1

Objective

Understanding the principles of biodiversity and strategies in germplasm conservation of fruit crops.

Theory

UNIT I

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.

UNIT II

Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ*.

UNIT III

Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

UNIT IV

Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

UNIT V

GIS and documentation of local biodiversity, Geographical indication.

Crops

Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus, *Prunus* sp, litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

Practical

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

Suggested Readings

Frankel, O.H. & Hawkes, J.G. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press.

Peter, K.V. & Abraham, Z. 2007. Biodiversity in Horticultural Crops. Vol. I. Daya Publ. House.

Peter, K.V. 2008. Biodiversity of Horticultural Crops. Vol. II. Daya Publ. House.

FSC 504 Canopy Management in Fruit Crops 1+1

Objective

To impart knowledge about the principles and practices in canopy management of fruit crops.

Theory

UNIT I

Canopy management - importance and advantages; factors affecting canopy development.

FSC 508 Growth and Development of Horticultural Crops 2+1

Objective

To develop understanding of growth and development of horticultural crops which have implications in their management.

Theory

UNIT I

Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.

UNIT II

Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism vernalisation, effect of temperature, heat units, thermoperiodism.

UNIT III

Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brasssinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors.

UNIT IV

Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.

UNIT V

Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical

manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Practical

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

Suggested Readings

Buchanan, B., Gruiessam, W. & Jones, R. 2002. Biochemistry & Molecular Biology of Plants. John Wiley & Sons.

Epstein, E. 1972. Mineral Nutrition of Plants: Principles and Perspectives.Wiley.

Fosket D.E. 1994. Plant Growth and Development: a Molecular Approach. Academic Press.

Leoplod, A.C. & Kriedermann, P.E. 1985. Plant Growth and Development. 3rd Ed. Mc Graw-Hill.

Peter, K.V. 2008. (Ed.) Basics of Horticulture. New India Publ. Agency.

Roberts, J., Downs, S. & Parker, P. 2002. Plant Growth Development. In: Plants (I. Ridge, Ed.), pp. 221-274, Oxford University Press.

Salisbury, F.B. & Ross, C.W. 1992. Plant Physiology. 4th Ed. Wadsworth Publ.

Note : For minor courses please refer the concerned department's courses outline .

VSC 501 Production Technology of cool season Vegetable Crops 2+1
Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT I

Potato

UNIT II

Cole crops: cabbage, cauliflower, knol khol, sprouting broccoli and Brussels sprout

UNIT III

Root crops: carrot, radish, turnip and beetroot

UNIT IV

Bulb crops: onion and garlic

UNIT V

Peas and broad bean, green leafy cool season vegetables

Practical

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

Salunkhe DK & Kadam SS. (1998). *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.

Shanmugavelu KG. (1989). *Production Technology of Vegetable Crops*. Oxford & IBH.

Singh DK. (2007). *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co. Lucknow

Singh SP. (1989). *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre, Karnal

Thamburaj S & Singh N. (2004). *Vegetables, Tuber Crops and Spices.* ICAR, New Delhi.

Thompson HC & Kelly WC. (1978). *Vegetable Crops*. Tata McGraw-Hill.

VSC 502 Production Technology of warm season Vegetable Crops 2+1

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of:

UNIT I
Tomato, eggplant, hot and sweet peppers

UNIT II
Okra, beans (French bean, Indian bean and cluster bean), cowpea

UNIT III
Cucurbitaceous crop

UNIT IV
Tapioca, sweet potato and colocasia

UNIT V
Green leafy warm season vegetables

Practical

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

Suggested Readings

Bose TK & Som MG. (1986). *Vegetable Crops in India*. Naya Prokash, Calcutta.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. (2003). *Vegetable Crops*. Vols. I-III. Naya Udyog.

Bose TK, Som MG & Kabir J. (2002). *Vegetable Crops*. Naya Prokash, Kolkata.

Brown HD & Hutchison CS. *Vegetable Science*. JB Lippincott Co.

Chadha KL & Kalloo G. (1993-94). *Advances in Horticulture*. Vols.V-X. Malhotra Publ. House, New Delhi.

Chadha KL. (2002). *Hand Book of Horticulture*. ICAR, New Delhi.

Chauhan DVS. (1986). *Vegetable Production in India*. Ram Prasad & Sons.

Decoteau DR. (2000). *Vegetable Crops*. Prentice Hall, New Delhi.

Edmond JB, Musser AM & Andrews FS. (1964). *Fundamentals of Horticulture*. Blakiston Co

Fageria MS, Choudhary BR & Dhaka RS. (2000). *Vegetable Crops: Production Technology*. Vol. II. Kalyani publishers, New Delhi.

Gopalakrishanan TR. (2007). *Vegetable Crops*. New India Publ. Agency, New Delhi.

Hazra P & Som MG. (1999). *Technology for Vegetable Production and Improvement*. Naya Prokash, Kolkata

UNIT V

Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops.

Practical

Preparation of solutions of plant growth substances and their application; experiments in breaking and induction of dormancy by chemicals; induction of parthenocarpy and fruit ripening; application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables; growth analysis techniques in vegetable crops.

Suggested Readings

Bleasdale JKA. (1984). *Plant Physiology in Relation to Horticulture*. 2nd Ed. MacMillan.

Gupta US. (1978). *Crop Physiology*. Oxford & IBH.

Krishnamoorti HN. (1981). *Application Plant Growth Substances and Their Uses in Agriculture*. Tata-McGraw Hill.

Peter KV. (2008). *Basics of Horticulture*. New India Publ. Agency, New Delhi.

Saini RS, Sharma KD, Dhankhar OP & Kaushik RA. (2001). *Laboratory Manual of Analytical Techniques in Horticulture*. Agrobios.

Wien HC. (1997). *The Physiology of Vegetable Crops*. CABI.

VSC 505 Seed Production Technology of Vegetable Crops 2+1

Theory

UNIT I

Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India.

UNIT II

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behavior, seed development and maturation; methods of hybrid seed production.

UNIT III

Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.

UNIT VI

Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

UNIT V

Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

Practical

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; rouging of off-type; methods of hybrid seed production in important vegetable and spice crops;

seed extraction techniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

Suggested Readings

Agrawal PK & Dadlani M. (1992). *Techniques in Seed Science and Technology*. South Asian Publ.

Agrawal RL. (1997). *Seed Technology*. Oxford & IBH.

Bendell PE. (1998). *Seed Science and Technology: Indian Forestry Species*. Allied Publ.

Fageria MS, Arya PS & Choudhary AK. (2000). *Vegetable Crops: Breeding and Seed Production*. Vol I. Kalyani Publishers, New Delhi.

George RAT. (1999). *Vegetable Seed Production*. 2nd Ed. CABI.

Kumar JC & Dhaliwal MS. (1990). *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.

More TA, Kale PB & Khule BW. (1996). *Vegetable Seed Production Technology*. Maharashtra State Seed Corp.

Rajan S & Baby L Markose. (2007). *Propagation of Horticultural Crops*. New India Publ. Agency.

Singh NP, Singh DK, Singh YK & Kumar V. (2006). *Vegetable Seed Production Technology*. International Book Distributing Co., Lucknow.

Singh SP. (2001). *Seed Production of Commercial Vegetables.* Agrotech Publ. Academy.

VSC 507 Production Technology of Underexploited Vegetable Crops 2+1

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of:

UNIT I

Asparagus, Jerusalem artichoke, leek and drumstick

UNIT II

Brussels's sprout, Chinese cabbage, broccoli, kale, Globe artichoke, tannia and curry leaf.

UNIT III

Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathua (chenopods) and chekurmanis.

UNIT IV

Elephant foot yam, dioscorea (greater yam, lesser yam and white yam), yam bean, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean.

UNIT V

Sweet gourd, spine gourd, pointed gourd, oriental pickling melon, little gourd (kundru), arrowroot and chinese potato.

Practical

Identification of seeds; botanical description of plants; layout and planting; cultural practices; short-term experiments of under exploited vegetables.

Suggested Readings

Bhat KL. (2001). *Minor Vegetables - Untapped Potential*. Kalyani Publishers, New Delhi.

Indira P & Peter KV. (1984). *Unexploited Tropical Vegetables*. Kerala Agricultural University, Kerala.

Peter KV. (2007-08). *Underutilized and Underexploited Horticultural Crops*. Vols. I-IV. New India Publ. Agency, New Delhi.

Rubatzky VE & Yamaguchi M. (1997). *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. (2001). *Minimal Descriptors of Agri-Horticultural Crops*. Part-II: *Vegetable Crops*. NBPGR, New Delhi.

VSC 508 Organic Vegetable Production Technology 1+1

Theor

UNIT I

Importance, principles, perspective, concept and component of organic production of vegetable crops.

UNIT II

Organic production of vegetables crops, *viz*., solanaceous crops, cucurbits, cole crops, root and tuber crops.

UNIT III

Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

UNIT IV

Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavya, Biodynamics, preparation etc Pest and disease management in organic farming; ITK's in organic farming. Role of botanicals and bio-control agents.

UNIT V

GAP and GMP- Certification of organic products; organic production and export -opportunity and challenges.

Practical

Method of preparation of compost, vermicomposting, biofertilizers, soil solarization, bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production, waster management, organic soil amendment for root disease, weed management in organic horticulture. Visit to organic fields and marketing centers.

Suggested Readings

Dahama AK. (2005). *Organic Farming for Sustainable Agriculture.* 2nd Ed. Agrobios, Jodhpur.

PSMA 501 Production of Plantation Crops 2+1

Objective

To impart basic knowledge about the importance and production technology of plantation crops grown in India.

Theory

Role of plantation crops in national economy, export potential, IPR issues, clean development mechanism, classification and varietal wealth. Plant multiplication including *in vitro* multiplication, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micro nutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting. Cost benefit analysis, organic farming, management of drought, precision farming.

Crops

UNIT I: Coffee and tea

UNIT II: Cashew and cocoa

UNIT III: Rubber, palmyrah and oil palm

UNIT IV: Coconut and arecanut

UNIT V: Wattle and betel vine

Practical

Description of botanical and varietal features, selection of mother palms and seedlings in coconut and arecanut, soil test crop response studies and manuring practices, pruning and training, maturity standards, harvesting, Project preparation for establishing plantations, Visit to plantations.

Suggested Readings

Anonymous, 1985. *Rubber and its Cultivation*. The Rubber Board of India.

Chopra VL & Peter KV. 2005. *Handbook of Industrial Crops*. Panima.

Harler CR. 1963. *The Culture and Marketing of Tea*. Oxford Univ. Press.

Kurian A & Peter KV. 2007. *Commercial Crops Technology*. New India Publ. Agency.

Nair MK, Bhaskara Rao EVV, Nambiar KKN & Nambiar MC. 1979. *Cashew*. CPCRI, Kasaragod.

Peter KV. 2002. *Plantation Crops*. National Book Trust.

Pradeep Kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. Part I, II. New India Publ. Agency.

Rai PS & Vidyachandram B. 1981. *Review of Work Done on Cashew*. UAS, Research Series No.6, Bangalore.

Ranganathan V. 1979. *Hand Book of Tea Cultivation*. UPASI, Tea Res. Stn. Cinchona.

Srivastava HC, Vatsaya B & Menon KKG. 1986. *Plantation Crops – Opportunities and Constraints*. Oxford & IBH.

Thampan PK. 1981. *Hand Book of Coconut Palm*. Oxford & IBH.

PSMA 502 Production Technology of Spice Crops 2+1

Objective

To impart basic knowledge about the importance and production technology of spices grown in India.

Theory

Introduction, importance of spice crops-historical accent, present status - national and international, future prospects, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, site selection, layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed planting material and micro-propagation, precision

farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of:

UNIT I

Black pepper, cardamom

UNIT II

Clove, cinnamon and nutmeg, allspice

UNIT III

Turmeric, ginger and garlic

UNIT IV

Coriander, fenugreek, cumin, fennel, ajowain, dill, celery

UNIT V

Tamarind, garcinia and vanilla

Practical

Identification of seeds and plants, botanical description of plant; preparation of herbarium, propagation, nursery raising, field layout and method of planting, cultural practices, harvesting, drying, storage, packaging and processing, value addition; short term experiments on spice crops.

Suggested Readings

Agarwal S, Sastry EVD & Sharma RK. 2001. *Seed Spices: Production, Quality, Export*. Pointer Publ.

Arya PS. 2003. *Spice Crops of India*. Kalyani.

Bhattacharjee SK. 2000. *Hand Book of Aromatic Plants*. Pointer Publ.

Bose TK, Mitra SK, Farooqi SK & Sadhu MK (Eds.). 1999. *Tropical Horticulture*. Vol.I. Naya Prokash.

Chadha KL & Rethinam P. (Eds.). 1993. *Advances in Horticulture*. Vols. IX-X. *Plantation Crops and Spices*. Malhotra Publ. House.

PSMA 505 Breeding of Medicinal and Aromatic Crops 2+1

Objective

To impart comprehensive knowledge about the principles and practices of breeding of plantation crops and spices.

Theory

UNIT I

Plant bio-diversity, conservation of germplasm, IPR issues, Major objectives of breeding of Medicinal and Aromatic Crops, Scope for introduction; cytogenetic background of important Medicinal and Aromatic Crops; Scope for improvement of Medicinal and Aromatic Crops through selection, intra and interspecific hybridization, induced autotetraploidy, mutation breeding and biotechnological approaches.

UNIT II

Breeding for yield and quality improvement in medicinal plants, Breeding for high herbage yield, essential oil and quality components, secondary metabolites in medicinal and aromatic crops; Genetics of active principles and assay techniques useful in evaluation of breeder's material. Breeding problems in seed and vegetatively propagated medicinal and aromatic crops.

UNIT III

Achievements and prospects in breeding of medicinal crops, *viz*. *Cassia angustifolia*, *Catharanthus roseus*, *Gloriosa superba*, *Coleus forskohlii*, Stevia, *Withania somnifera*, *Papaver somniferum*, *Plantago ovata*, *Dioscorea* sp.

UNIT IV

Prospects in breeding of medicinal crops, *viz*. *Chlorophytum* sp, *Rauvolfia serpentina*, *Aloe vera*, *Ocimum* sp, *Phyllanthus amarus*, *Solanum* sp.

UNIT V

Prospects in breeding of aromatic crops viz., Geranium, vettiver, Lemon grass, Palmarosa, citronella, Rosemary, Patchouli, Eucalyptus, Artemisia and Mint.

Practical

Description of Botanical features, Cataloguing of cultivars, varieties and species in medicinal and aromatic crops, Floral Biology, Selfing and crossing, Evaluation of hybrid progenies, Induction of economic mutants, High alkaloid and high essential oil mutants, evolution of mutants through physical and chemical mutagens, Introduction of polyploidy, Screening of plants for biotic and abiotic stress and environmental pollution, *in-vitro* breeding in medicinal and aromatic crops.

Suggested Readings

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.

Chadha KL & Gupta R. 1995. *Advances in Horticulture*. Vol. XI. Malhotra Publ. House.

Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops.* Natural Remedies Pvt. Ltd.

Jain SK. 2000. *Medicinal Plants*. National Book Trust.

Julia F & Charters MC. 1997. *Major Medicinal Plants – Botany, Cultures and Uses*. Thomas Publ.

Kurian A & Asha Sankar, M. 2007. *Medicinal Plants.* Horticulture Science Series, New India Publ. Agency.

Prajapati ND, Paero Hit SS, Sharma AK, Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios (India).

Skaria P Babu. 2007. *Aromatic Plants*. New India Publ. Agency.

Thakur RS, Pauri HS & Hussain A. 1989. *Major Medicinal Plants of India* CSIR.

PSMA 507 Organic Spice and Plantation Crop Production Technology 2+1

Objective

To educate principles, concepts and production of organic farming in spice and plantation crops.

Theory

UNIT I

Importance, principles, perspective, concept and component of organic production of spice and plantation crops.

UNIT II

Organic production of spice crops and plantation crops, *viz.* pepper, cardamom, turmeric, ginger, cumin, vanilla, coconut, coffea, cocoa, tea, arecanut.

UNIT III

Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

UNIT IV

Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavvya, Biodynamics, preparation etc.; Pest and disease management in organic farming; ITK's in organic farming. Role of botanicals and bio-control agents.

UNIT V

GAP and GMP- Certification of organic products; organic production and export - opportunity and challenges.

Practical

Method of preparation of compost, vermicomposting, biofertilizers, soil solarization, bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production, waster management, organic soil

amendment for root disease, weed management in organic horticulture. Visit to organic fields and marketing centers.

Suggested Readings

Dahama AK. 2005. *Organic Farming for Sustainable Agriculture*. 2nd Ed. Agrobios.

Gehlot G. 2005. *Organic Farming: Standards, Accreditation, Certification and Inspection*. Agrobios.

Palaniappan SP & Annadorai K. 2003. *Organic Farming: Theory and Practice*. Scientific Publ.

Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. New India Publ. Agency.

Shivashankar K. 1997. *Food Security in Harmony with Nature*. 3rd IFOAMASIA,

Scientific Conference. 1-4 Dec., 1997, UAS, Bangalore.

Note : For minor courses please refer the concerned department's courses outline .

FLA 501 Breeding of Flower Crops and Ornamental Plants 2+1

Objective

To impart comprehensive knowledge about the principles and practices of breeding of flower crops and ornamental plants.

Theory

UNIT I

Principles -- Evolution of varieties, origin, distribution, genetic resources, genetic divergence- Patents and Plant Variety Protection in India.

UNIT II

Genetic inheritance -- of flower colour, doubleness, flower size, fragrance, post harvest life.

UNIT III

Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants-- introduction, selection, domestication, polyploid and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops.

UNIT IV

Breeding constraints and achievements made in commercial flowers - rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia,gerbera, gladioli, orchids, anthurium, aster, heliconia, liliums, nerium.

UNIT V

Breeding constraints and achievements made in ornamental plants – petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos,dianthus, snap dragon, pansy) and ornamental foliages– Introduction and selection of plants for waterscaping and xeriscaping.

Practical

Description of botanical features– Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production-Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Chadha KL & Choudhury B.1992. *Ornamental Horticulture in India.* ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Chaudhary RC. 1993. *Introduction to Plant Breeding.* Oxford & IBH.

Singh BD. 1990. *Plant Breeding*. Kalyani.

FLA 502 Production Technology of Cut Flowers 2+1

Objective

To impart basic knowledge about the importance and production technology of cut flowers grown in India.

Theory

UNIT I

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.

UNIT II

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO2 on growth and flowering.

UNIT III

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT IV

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

Crops

Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

Practical

Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study.

Practical

Selection of ornamental plants**,** practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.

Nambisan KMP. 1992. *Design Elements of Landscape Gardening*. Oxford & IBH.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.

Valsalakumari et al. 2008. *Flowering Trees*. New India Publ. Agency.

Woodrow MG.1999. *Gardening in India.* Biotech Books.

FLA 505 Protected Floriculture 2 + 1

Objective

Understanding the principles, theoretical aspects and developing skills in protected cultivation of flower crops.

Theory

UNIT I

Prospects of protected floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures – economics of cultivation; Location specific

designs; Structural components; Suitable flower crops for protected cultivation.

UNIT II

Environment control – management and manipulation of temperature, light, humidity, air and CO2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT III

Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM.

UNIT IV

Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation.

UNIT V

Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards.

Practical

Study of various protected structures, practices in design, layout and erection of different types of structures, practices in preparatory operations, soil decontamination techniques, practices in environmental control systems, practices in drip and fertigation techniques, special horticultural practices, determination of harvest indices and harvesting methods, postharvest handling, packing methods, project preparation, visit to commercial greenhouses.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

FLA 507 Turfing and Turf Management 2+1

Objective

To develop understanding of the principles and management of turfing.

Theory

UNIT I

Prospects of landscape industry; History of landscape gardening, site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment.

UNIT II

Turf grasses - Types, species, varieties, hybrids; Selection of grasses for different locations; Grouping according to climatic requirement-Adaptation; Turfing for roof gardens.

UNIT III

Preparatory operations; Growing media used for turf grasses – Turf establishment methods, seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing.

UNIT IV

Turf management – Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing -- mowing equipments, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs.

UNIT V

Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, etc.

Practical

Identification of turf grasses, Preparatory operations in turf making, Practices in turf establishment, Layout of macro and micro irrigation systems, Water and nutrient management; Special practices – mowing, raking, rolling, soil top dressing, weed management; Biotic and abiotic

stress management; Project preparation for turf establishment, visit to IT parks, model cricket and golf grounds, airports, corporates, Govt. organizations; Renovation of lawns; Turf economics.

Suggested Readings

Nick-Christians 2004. *Fundamentals of Turfgrass Management*. www.amazon.com

Chadha KL & Chaudhury B.1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.

Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India.* Allied Publ.

Sheela VL. 2007. *Flowers in Trade*. New India Publ. Agency.

Valsalakumari PK, Rajeevan PK, Sudhadevi PK & Geetha CK. 2008. *Flowering Trees*. New India Publ. Agency.

Note : For minor courses please refer the concerned department's courses outline.

of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

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

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

Theory

UNIT I

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

UNIT II

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

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

Suggested Readings

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

Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.

Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

PGS 506 DISASTER MANAGEMENT 1+0 (e-Course)

Objectives To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters - Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic

eruptions, Heat and cold waves, Climatic change: Global warming, Sea level rise, Ozone depletion.

UNIT II

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

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

AGRON 501 Modern Concepts in Crop Production 3+0

Objective

To teach the nebasic concepts of soil management and crop production.

Theory

UNIT I

Crop growth analysis in relation to environment; agro-ecological zones of India.

UNIT II

Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.

UNIT III

Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

UNIT IV

Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.

UNIT V

Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture.

Suggested Readings

Balasubramaniyan P & Palaniappan SP. 2001. *Principles and Practices of Agronomy*. Agrobios.

Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.

Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.

Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.

Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publ.

Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.

Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

AGRON 502 Soil Fertility and Nutrient Management 2+1

Objective

To impart knowledge of fertilizers and manures as sources of plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil fertility.

Theory

UNIT I

Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.

UNIT II

Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

UNIT III

Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management.

UNIT IV

Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interactions.

UNIT V

Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermincompost and residue wastes in crops.

Practical

- Determination of soil pH, ECe, organic C, total N, available N, P, K and S in soils Determination of total N, P, K and S in plants
- Interpretation of interaction effects and computation of economic and yield optima

Suggested Readings

Brady NC & Weil R.R 2002. *The Nature and Properties of Soils.* 13th Ed. Pearson Edu.

Fageria NK, Baligar VC & Jones CA. 1991. *Growth and Mineral Nutrition of Field Crops.* Marcel Dekker.

Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers.* 7th Ed. Prentice Hall.

Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.

Yawalkar KS, Agrawal JP & Bokde S. 2000. *Manures and Fertilizers*. Agri-Horti Publ.

AGRON 503 Principles and Practices of Weed Management 2+1

Objective

To familiarize the students about the weeds, herbicides and methods of weed control.

Theory

UNIT I

Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices.

UNIT II

Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.

UNIT III

Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio-herbicides, myco-herbicides and allelochemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation.

UNIT IV

Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control.

UNIT V

Integrated weed management; cost: benefit analysis of weed management.

Practical

- Identification of important weeds of different crops. Preparation of a weed herbarium
- Weed survey in crops and cropping systems Crop-weed competition studies
- Preparation of spray solutions of herbicides for high and low-volume sprayers
- Use of various types of spray pumps and nozzles and calculation of swath width
- Economics of weed control. Herbicide resistance analysis in plant and soil
- Bioassay of herbicide resistance Calculation of herbicidal requirement

Suggested Readings

Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.

Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley Inter-Science.

Gupta OP. 2007. *Weed Management – Principles and Practices.* Agrobios.

Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.

Rao VS. 2000. *Principles of Weed Science*. Oxford & IBH.

Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani.

Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

AGRON 504 Principles and Practices of Water Management 2+1

Objective

To teach the principles of water management and practices to enhance the water productivity.

Theory

UNIT I

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

UNIT II

Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition.

UNIT III

Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; microirrigation system; fertigation; management of water in controlled environments and polyhouses.

UNIT IV

Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency.

UNIT V

Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.

Practical

- Measurement of soil water potential by using tensiometer, and pressure plate and membrane apparatus
- Soil-moisture characteristics curves. Water flow measurements using different devices
- Determination of irrigation requirements. Calculation of irrigation efficiency
- Determination of infiltration rate. Determination of saturated/ unsaturated hydraulic conductivity

Suggested Readings

Lenka D. 1999. *Irrigation and Drainage*. Kalyani

Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.

Paliwal KV. 1972. *Irrigation with Saline Water*. IARI Monograph, New Delhi.

Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.

Prihar SS & Sandhu BS. 1987. *Irrigation of Food Crops - Principles and Practices*. ICAR.

Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

Singh Pratap & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture*. Agrotech Publ.

AGRON 511 Cropping Systems and Sustainable Agriculture 2+0

Objective

To acquaint the students about prevailing cropping systems in the country and practices to improve their productivity.

Theory

UNIT I

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

UNIT II

Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

UNIT III

Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

UNIT IV

Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system.

UNIT V

Plant ideo types for dry lands; plant growth regulators and their role in sustainability.

Suggested Readings

Palaniappan SP & Sivaraman K. 1996. Cropping Systems in the Tropics; Principles and Management. New Age.

Panda SC. 2003. Cropping and Farming Systems. Agrobios.

Reddy SR. 2000. Principles of Crop Production. Kalyani.

Sankaran S & Mudaliar TVS. 1997. Principles of Agronomy. The Bangalore Printing & Publ. Co.

Singh SS. 2006. Principles and Practices of Agronomy. Kalyani.

Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1997. Soil Fertility and Fertilizers. Prentice Hall.

AGRON 512 Dryland Farming and Watershed Management 2+1

Objective

To teach the basic concepts and practices of dry land farming and soil moisture conservation.

Theory

UNIT I

Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture.

UNIT II

Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.

UNIT III

Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.

UNIT IV

Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); antitranspirants; soil and crop management techniques, seeding and efficient fertilizer use.

UNIT V

Concept of watershed resource management, problems, approach and components.

Practical

- Seed treatment, seed germination and crop establishment in relation to soil moisture contents
- Moisture stress effects and recovery behaviour of important crops

- Estimation of moisture index and aridity index
- Spray of anti-transparent and their effect on crops
- Collection and interpretation of data for water balance equations
- Water use efficiency
- Preparation of crop plans for different drought conditions
- Study of field experiments relevant to dryland farming
- Visit to dryland research stations and watershed projects

Suggested Readings

Das NR. 2007. *Tillage and Crop Production*. Scientific Publishers.

Dhopte AM. 2002. *Agrotechnology for Dryland Farming*. Scientific Publ.

Dhruv Narayan VV. 2002. *Soil and Water Conservation Research in India*. ICAR.

Gupta US. (Ed.). 1995. *Production and Improvements of Crops for Drylands*. Oxford & IBH.

Katyal JC & Farrington J. 1995. *Research for Rainfed Farming*. CRIDA.

Rao SC & Ryan J. 2007. *Challenges and Strategies of Dryland Agriculture*. Scientific Publishers.

Singh P & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture.* Agrotech Publishing Company.

Singh RP. 1988. *Improved Agronomic Practices for Dryland Crops.* CRIDA.

Singh RP.2005. *Sustainable Development of Dryland Agriculture in India*. Scientific Publ.

Singh SD. 1998. *Arid Land Irrigation and Ecological Management*. Scientific Publishers.

Venkateshwarlu J. 2004. *Rainfed Agriculture in India. Research and Development Scenario*. ICAR.

AGRON 513 Principles and Practices of Organic Farming 2+1

Objective

To study the principles and practices of organic farming for sustainable crop production.

Theory

UNIT I

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.

UNIT II

Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers.

UNIT III

Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

UNIT IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides.

UNIT V

Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practical

- Aerobic and anaerobic methods of making compost. Making of vermicompost
- Identification and nursery raising of important agro-forestry tress and tress for shelter belts
- Efficient use of biofertilizers, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum*, and PSB cultures in field
- Visit to an organic farm

- Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

Suggested Readings

Ananthakrishnan TN. (Ed.). 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.

Gaur AC. 1982. *A Manual of Rural Composting*, FAO/UNDP Regional Project Document, FAO.

Lampin N. 1990. *Organic Farming*. Press Books, lpswitch, UK.

Palaniappan SP & Anandurai K. 1999. *Organic Farming – Theory and Practice.* Scientific Publ.

Rao BV Venkata. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*: Publ.3, Parisaraprajna Parishtana, Bangalore.

Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.

Sharma A. 2002. *Hand Book of Organic Farming*. Agrobios.

Singh SP. (Ed.) 1994. *Technology for Production of Natural Enemies.* PDBC, Bangalore.

SubbaRao NS. 2002. *Soil Microbiology*. Oxford & IBH.

Trivedi RN.1993. *A Text Book of Environmental Sciences*, Anmol Publ.

Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture.* Association for Promotion of Organic Farming, Bangalore.

WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture*. WHO.

Woolmer PL & Swift MJ. 1994. *The Biological Management of Tropical Soil Fertility*. TSBF & Wiley.

Note : For minor courses please refer the concerned department's courses outline.

UNIT II

Simplex Method: Concept of simplex Method, solving profit maximization and cost minimizations problems. Formulation of farms and non farm problems as linear programming models and solutions.

UNIT III

Extension of Linear Programming models: Variable resource and price programming, transportation problems, recursive programming, dynamic programming.

UNIT IV

Game Theory- Concepts of game theory, two person constant sum, zero sumgame, saddle point, solution to mixed strategies, the rectangular game as Linear Programme.

Practical

Graphical and algebraic formulation of linear programming models. Solving of maximization and minimization problems by simplex method. Formulation of the simplex matrices for typical farm situations.

Suggested Readings

Dorfman R. 1996. *Linear Programming & Economic Analysis*. McGraw Hill.

Loomba NP. 2006. *Linear Programming*. Tata McGraw Hill.

Shenoy G. 1989. *Linear Programming-Principles & Applications*. Wiley Eastern Publ.

Vaserstein. 2006. *Introduction to Linear Programming*. Pearson Education Publication

AG ECON 509 Agricultural Finance and Project Management 2+1

Objective

The Course Objective of the course is to impart knowledge on issues related to lending to priority sector credit management and financial risk management. The course would bring in the various appraisal techniques in project - investment of agricultural projects.

Theory

UNIT I

Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Direct and Indirect Financing -Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's - NGO's, and SHG's.

UNIT II

Lending to farmers – The concept of 3 C's, 7 P's and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.

UNIT III

Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/firm.

UNIT IV

Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects.Net work Techniques – PERT and CPM.

UNIT V

Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes – review of different crop insurance schemes – yield loss and weather based insurance and their applications.

Practical

Development of Rural Institutional Lending - Branch expansion, demand and supply of institutional agricultural credit and Over dues and Loan waiving- : An overview, Rural Lending Programmes of Commercial Banks, Lead Bank Scheme-Preparation of District Credit Plan, Rural Lending Programmes of Co-operative Lending Institutions, Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements, Performance of Micro Financing Institutions - NGO's and Self-Help Groups, Identification and formulation of investment projects, Project appraisal techniques – Undiscounted Measures and their limitations. Project appraisal techniques – Discounted Measures, Network techniques – PERT and CPM for project management, Case Study Analysis of an Agricultural project, Financial Risk and risk management strategies – crop insurance schemes, Financial instruments and methods – E banking, Kisan Cards and core banking.

Suggested Readings

Dhubashi PR. 1986. *Policy and Performance - Agricultural and Rural Development in Post Independent India*. Sage Publ.

Gittinger JP 1982. *Economic Analysis of Agricultural Projects***.** The Johns Hopkins Univ. Press.

Gupta SC. 1987. *Development Banking for Rural Development*. Deep & Deep Publ.

Little IMD & Mirlees JA. 1974. *Project Appraisal and Planning for Developing Countries***.** Oxford & IBH Publ.

Muniraj R. 1987. *Farm Finance for Development*. Oxford & IBH Publ.

Note: For minor courses please refer the concerned department's courses outline.

GP 503 Principles of Plant Breeding 2+1

Objective

To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

Theory

UNIT I

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.

UNIT II

Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

UNIT III

Self-incompatibility and male sterility in crop plants and their commercial exploitation.

UNIT III

Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach).

UNIT IV

Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and interpopulation improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of

heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

UNIT V

Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection.

UNIT VI

Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding.

UNIT VII

Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses.

UNIT VIII

Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops.

Suggested Readings

Allard RW. 1981. *Principles of Plant Breeding*. John Wiley & Sons.

Chopra VL. 2001. *Breeding Field Crops*. Oxford & IBH.

Chopra VL. 2004. *Plant Breeding*. Oxford & IBH.

Gupta SK. 2005. *Practical Plant Breeding*. Agribios.

Pohlman JM & Bothakur DN. 1972. *Breeding Asian Field Crops*. Oxford & IBH.

Suggested Readings

Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, New York.

Dhaliwal GS & Arora R. 2001. *Integrated Pest Management: Concepts and Approaches.* Kalyani Publ., New Delhi.

Gerson H & Smiley RL.1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman & Hall, New York.

Huffaker CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

Ignacimuthu SS & Jayaraj S. 2003. *Biological Control of Insect Pests.* Phoenix Publ., New Delhi.

Saxena AB. 2003. *Biological Control of Insect Pests*. Anmol Publ., New Delhi.

Van Driesche & Bellows TS. Jr. 1996. *Biological Control*. Chapman & Hall, New York.

ENT 508 Toxicology of Insecticides 2+1

Objective

To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Theory

Unit I

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

Unit II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of

organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc.

Unit III

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.

Unit IV

Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

Unit V

Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning. Sprayers, dusters and other plant protection appliances.

Practical

Insecticide formulations and mixtures; quality control of pesticide formulations; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Pesticide appliances: Principles, operation and maintenance. Working out doses and concentrations of pesticides; visit to toxicology laboratories. Good laboratory practices.

Suggested Readings

Chattopadhyay SB. *1985. Principles and Procedures of Plant Protection.* Oxford & IBH, New Delhi.

Gupta HCL. 1999. *Insecticides: Toxicology and Uses.* Agrotech Publ., Udaipur.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.*Plenum Press, New York.

Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.*Narosa Publ. House, New Delhi.

Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

ENT 510 Principles of Integrated Pest Management 1+1

Objective

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM**.** Train students in computation of ETL, implementing IPM programmes.

Theory

Unit I

History and origin, scope and need for IPM, definition and evolution of various related terminologies.

Unit II

Concept and philosophy, ecological principles, economic threshold concept, and economic consideration.

Unit III

Tools of pest management and their integration- legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.

Practical

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses,

unavoidable losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system. Visit to IPM fields.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* 1st Ed., Springer, New York.

Horowitz AR & Ishaaya I. 2004. *Insect Pest Management: Field and Protected Crops*. Springer, New Delhi.

Ignacimuthu SS & Jayaraj S. 2007. *Biotechnology and Insect Pest Management*. Elite Publ., New Delhi.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons, New York.

Pedigo RL. 2002. *Entomology and Pest Management.* 4th Ed. Prentice Hall, New Delhi.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concepts in Integrated Pest Management.* Prentice Hall, New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

ENT 511 Pests of Field Crops 1+1

Objective

To familiarize the students about nature of damage and seasonal incidence of insect pests that cause loss to major field crops and their effective management by different methods.

Theory

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors.

DEPARTMENT OF EXTENSION EDUCATION

EXT 501 Development Perspectives of Extension Education (1+1)

Theory

UNIT I

Extension Education – Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions – Extension Education as a Profession – Adult Education and Distance Education.

UNIT II

Pioneering Extension efforts and their implications in Indian Agricultural Extension, Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University

UNIT III

Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development.

UNIT IV

Current Approaches in Extension: Decentralized Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centers, and NAIP.

Practical

Visit to Gram Panchayat to study on-going Rural Development Programmes, Visit to KVK, NGO and Extension centers of State Agricultural University and State Departments, Bottom up planning, Report preparation and presentations.

Suggested Readings

Chandrakandan KM, Senthil Kumar & Swatilaxmi. PS. 2005. *Extension Education What? And What Not?* RBSA Publ.

Gallagher K. 1999. *Farmers Field School (FFS) – A Group Extension Processbased on Non-Formal Education Methods*. Global EPM Facility, FAO.

Ganesan R, Iqbal IM & Anandaraja N. 2003. *Reaching the Unreached: Basics of Extension Education*. Associated Publishing Co.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension*. Concept Publ.

Khan PM. 2002. *Textbook of Extension Education*. Himalaya Publ.

Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ.

Van Den Ban AW & Hawkins HS. 1998. *Agricultural Extension*. 2nd Ed. CBS.

Viswanathan M. 1994. *Women in Agriculture and Rural Development*. Printwell Publ.

EXT 502: Development Communication and Information Management 2+1

Theory

UNIT I

Communication process – concept, elements and their characteristics – Models and theories of communication – Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication – Barriers in communication, Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.

Multimedia, Online, Offline Extension, Tools-Mobile technologies, e-learning concepts

UNIT IV

ICT Extension: approaches-pre-requisites, information and science needs of farming community, Need integration, Human resource information, Intermediaries. Basic e-extension training issues, ICT enabled extension pluralism, emerging issues in ICT.

Practical

Agril. Content Analysis of ICT Projects, Handling of ICT tools, Designing extension content, online extension service, and project work on ICT enabled extension, Creation of extension blogs, Visit to ICT extension projects.

Suggested Readings

Batnakar S & Schware R. 2000. *Information and Communication Technology in Development- Cases from India*. Sage Publ.

Meera SN. 2008. *ICTs in Agricultural Extension: Tactical to Practical*. Ganga- Kaveri Publ. House. JangamWadiMath, Varanasi.

Willem Zip. 1994. *Improving the Transfer and Use of Agricultural Information – A Guide to Information Technology*. The World Bank, Washington.

EXT 506 Entrepreneurship Development and Management in Extension (2+1)

Theory

UNIT I

Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development, Agri – entrepreneurship – Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs – Risk taking, Leadership, Decision making,

Planning, Organizing, Coordinating and Marketing, Types of Entrepreneurs Stages of establishing enterprise – Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects

UNIT II

Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC industries, Micro financing – meaning, Sources of Finance, Banks, Small scale industries development organizations. Marketing for enterprises – Concept, planning for marketing, target marketing, Competition, market survey and strategies, Product sales and promotion. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Success and Failure stories for enterprises – Issues relating to success and failure of enterprises – Personal, Production, Finance, Social, Marketing

UNIT III

Management – Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Making planning effective. Change Management – factors, process and procedures. Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions. Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations.

UNIT IV

Coordination: Concept, Need, Types, Techniques of Coordination, Interpersonal relations in the organization, Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods. Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles, Organizational Communication – Concept, Process, Types, Net Works, Barriers to Communication, Managing work motivation – Concept, Motivation and Performance, Approaches to motivation. Supervision –Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision, Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.

Practical

Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs Development of Project Proposal -Case Studies of Success / Failure enterprises-Exercise on Market Survey-Field visit to Financial institutions- Simulated exercise to understand management process-Field visit to extension organizations to understand the functions of management -Group exercise on development of short term and long term plan-Simulated exercise on techniques of decision making-Designing organizational structure -Group activity on leadership development skills.

Suggested Readings

Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand & Sons.

Indu Grover. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public Academy.

Khanka SS. 1999. *Entrepreneurial Development*. S. Chand & Co.

Singh D. 1995. *Effective Managerial Leadership*. Deep & Deep Publ.

PL PATH 516 Integrated Disease Management 2+1

Objective

To emphasize the importance and need of IDM in the management of diseases of important crops.

Theory

UNIT I

Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications.

UNIT II

Development of IDM- basic principles, biological, chemical and cultural disease management.

UNIT III

IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed , mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.

Practical

Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM; demonstration of IDM in certain crops as project work.

Suggested Readings

Gupta VK & Sharma RC. (Eds). 1995. *Integrated Disease Management and Plant Health*. Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases*. Daya Publ. House, New Delhi. 78

Sharma RC & Sharma JN. (Eds). 1995. *Integrated Plant Disease Management*. Scientific Publ., Jodhpur.

SOILS 503 Soil Chemistry 2+1

Objective

To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

UNIT I

Chemical (elemental) composition of the earth's crust and soils.

UNIT II

Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

UNIT III

Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layertheories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions.

UNIT IV

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange – innersphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.

UNIT V

Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects.

UNIT VI

Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity.

UNIT VII

Chemistry of salt-affected soils and amendments; soil pH, EC_e, ESP, SAR and important relations; soil management and amendments.

UNIT VIII

Chemistry and electrochemistry of submerged soils.

Practical

- Determination of CEC and AEC of soils
- Analysis of equilibrium soil solution for pH, EC, E_h by the use of E_h-pH meter and conductivity meter
- Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method
- Potentiometric and conductometric titration of soil humic and fulvic acids
- (E_4/E_6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the Δ (E_4/E_6) values at two pH values
- Adsorption-desorption of phosphate/sulphate by soil using simpleadsorption isotherm
- Construction of adsorption envelope of soils by using phosphate/fluoride/ sulphate and ascertaining the mechanism of the ligand exchange process involved
- Determination of titratable acidity of an acid soil by $BaCl_2$-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil.* Oxford and IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.

Greenland DJ & Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.

McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press.

Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ. Press.

Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.

Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.

Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.

Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SOILS 504 Soil Mineralogy, Genesis, Classification and Survey 2+1

Objective

To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis in terms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

UNIT I

Fundamentals of crystallography, space lattice, coordination heory, isomorphism and polymorphism.

UNIT II

Classification, structure, chemical composition and properties of clayminerals; genesis and transformation of crystalline and non-crystalline clayminerals; identification techniques; amorphous soil constituents and other on-crystalline silicate minerals and their identification; clay minerals in Indian soils.

UNIT III

Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

UNIT IV

Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soilmaps – usefulness.

UNIT V

Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.

UNIT VI

Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes inthe framework of agro-ecosystem.

Practical

- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different landforms
- Classification of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soils using available data base in terms of soil quality
- Aerial photo and satellite data interpretation for soil and land use
- Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales
- Land use planning exercises using conventional and RS tools

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.

Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.

Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi

Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.

USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.

Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.

Wilding LP & Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*.Elsevier.

Wilding NE & Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*. I. *Concept and Interaction*. Elsevier.

SOILS 506 Soil Biology and Biochemistry 2+1

Objective

To teach students the basics of soil biology and biochemistry, including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

Theory

UNIT I

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

UNIT II

Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora.

UNIT III

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, humus formation; cycles of important organic nutrients.

UNIT IV

Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

UNIT V

Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost.

UNIT VI

Biofertilizers – definition, classification, specifications, method of production and role in crop production.

Practical

- Determination of soil microbial population Soil microbial biomass
- Elemental composition, fractionation of organic matter and functional groups
- Decomposition of organic matter in soil Soil enzymes
- Measurement of important soil microbial processes such as ammonification, nitrification, N_2 fixation, S oxidation, P solubilization and mineralization of other micro nutrients
- Study of rhizosphere effect

Suggested Readings

Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.

Burges A & Raw F. 1967 . *Soil Biology*. Academic Press.

McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.

Metting FB. 1993. *Soil Microbial Ecology – Applications in Agricultural and Environmental Management*. Marcel Dekker.

Paul EA & Ladd JN. 1981. *Soil Biochemistry*. Marcel Dekker.

Reddy MV. (Ed.). *Soil Organisms and Litter in the Tropics*. Oxford & IBH.

Russel RS. 1977. *Plant Root System: Their Functions and Interaction with the Soil*. ELBS & McGraw Hill. 92

Stotzky G & Bollag JM. 1993. *Soil Biochemistry.* Vol. VIII. Marcel Dekker.

Sylvia DN. 2005. *Principles and Applications of Soil Microbiology*. Pearson Edu.

Wild A. 1993. *Soil and the Environment - An Introduction*. Cambridge Univ. Press.

SOILS 510 Remote Sensing and GIS Techniques for Soil, Water and Crop Studies 2+1

Objective

To impart knowledge about the basic concepts of remote sensing, aerial photographs and imageries, and their interpretation; application of remote sensing in general and with special reference to soil, plants and yield forecasting; to impart knowledge about geo-statistical techniques with special reference to rigging, and GIS and applications in agriculture.

Theory

UNIT I

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter.

UNIT II

Sensor systems - camera, microwave radiometers and scanners; fundamentals of aerial photographs and image processing and interpretations.

UNIT III

Application of remote sensing techniques - land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, wasteland identification and management.

UNIT IV

Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of soil variability.

UNIT V

Introduction to GIS and its application for spatial and non-spatial soil and land attributes.

Practical

- Familiarization with different remote sensing equipments and data products
- Interpretation of aerial photographs and satellite data for mapping of and resources
- Analysis of variability of different soil properties with classical and geostatistical techniques
- Creation of data files in a database programme
- Use of GIS for soil spatial simulation and analysis
- To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Elangovan K. 2006. *GIS Fundamentals, Applications and Implementations*. New India Publ. Agency.

Lillesand TM & Kiefer RW. 1994. *Remote Sensing and Image Interpretation*. 3rd Ed. Wiley.

Nielsen DR & Wendroth O. 2003. *Spatial and Temporal Statis*tics. Catena Verloggmbh.

Star J & Esles J. 1990. *Geographic Information System: An Introduction*. Prentice Hall.

Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers.* 5th Ed. Prentice Hall of India.

Troeh FR & Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.

SOILS 501 Soil Physics 2+1

Objective

To impart basic knowledge about soil physical properties and processes in relation to plant growth.

Theory

UNIT I

Scope of soil physics and its relation with other branches of soil science; soil as a three phase system.

UNIT II

Soil texture, textural classes, mechanical analysis, specific surface.

UNIT III

Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts.

UNIT IV

Soil structure - genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation.

UNIT V

Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential.

UNIT VI

Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy'slaw; hydraulic conductivity, permeability and fluidity,

hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils.

UNIT VII

Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum.

UNIT IX

Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management.

UNIT X

Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

Practical

- Mechanical analysis by pipette and international methods
- Measurement of Atterberg limits
- Aggregate analysis - dry and wet
- Measurement of soil-water content by different methods
- Measurement of soil-water potential by using tensiometer and gypsumblocks
- Determination of soil-moisture characteristics curve and computation of pore-size distribution
- Determination of hydraulic conductivity under saturated and unsaturated conditions
- Determination of infiltration rate of soil
- Determination of aeration porosity and oxygen diffusion rate
- Soil temperature measurements by different methods
- Estimation of water balance components in bare and cropped fields

Suggested Readings

Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.

Ghildyal BP & Tripathi RP. 2001. *Soil Physics*. New Age International.

Hanks JR & Ashcroft GL. 1980. *Applied Soil Physics*. Springer Verlag.

Hillel D. 1972. *Optimizing the Soil Physical Environment toward Greater Crop Yields*. Academic Press.
Hillel D. 1980. *Applications of Soil Physics*.Academic Press.
Hillel D. 1980. *Fundamentals of Soil Physics*.Academic Press.
Hillel D. 1998. *Environmental Soil Physic*s.Academic Press.
Hillel D. 2003. *Introduction to Environmental Soil Physics*. Academic Press.
Indian Society of Soil Science. 2002. *Fundamentals of Soil Science.* ISSS, New Delhi.
Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley-Interscience.
Kohnke H. 1968. *Soil Physics*.McGraw Hill.
Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
Oswal MC. 1994. *Soil Physics*.Oxford & IBH.
Saha AK. 2004. *Text Book of Soil Physics*. Kalyani.

SOILS 509 Soil, Water and Air Pollution 2+1

Objective

To make the students aware of the problems of soil, water and air pollution associated with use of soils for crop production.

Theory

UNIT I

Soil, water and air pollution problems associated with agriculture, nature and extent.

UNIT II

Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.

UNIT III

Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal.

UNIT IV

Pesticides – their classification, behavior in soil and effect on soil microorganisms.

UNIT V

Toxic elements–their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

UNIT VI

Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases–carbon dioxide, methane & nitrous oxide.

UNIT VIII

Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

Practical

- Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants
- Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in effluents
- Heavy metals in contaminated soils and plants
- Management of contaminants in soil and plants to safeguard food safety
- Air sampling and determination of particulate matter and oxides of sulphur
- Visit to various industrial sites to study the impact of pollutants on soil and plants

Suggested Readings

Lal R, Kimble J, Levine E & Stewart BA. 1995. *Soil Management and Greenhouse Effect.*CRC Press.

Middlebrooks EJ. 1979. *Industrial Pollution Control*. Vol. I. *Agro-Industries*. John Wiley Interscience. Ross SM. *Toxic Metals in Soil Plant Systems*. John Wiley & Sons.

Vesilund PA & Pierce 1983. *Environmental Pollution and Control*. Ann Arbor Science Publ.

Note : For minor courses please refer the concerned department's courses outline.

MBB 501 PRINCIPLES OF BIOTECHNOLOGY3 (2+1)

Objective: To familiarize the students with the fundamental principles of Biotechnology, various developments in Biotechnology and its potential applications.

Theory

UNIT I History, scope and importance, DNA structure, function and metabolism

UNIT II DNA modifying enzymes and vectors, Methods of recombinant DNA technology Nucleic acid hybridization, Gene libraries; PCR amplification, Plant and animal cell and tissue culture techniques and their applications.

UNIT III Molecular markers and their applications, DNA sequencing: Applications of gene cloning in basic and applied research, Genetic engineering and transgenics, Genomics, transcriptomics and proteomics.

UNIT IV General application of biotechnology in Agriculture, Medicine, Animal husbandry. Environmental remediation. Energy production and Forensics, Public perception of biotechnology, Bio-safety and bioethics issues, Intellectual property rights in biotechnology

Practical

Isolation of genomic and plasmid DNA

Gel electrophoresis techniques

Restriction enzyme digestion, ligation, transformation and screening of transformants PCR and molecular marker analysis

Plant tissue culture media preparation, cell and explant culture, regeneration and transformation

Suggested Readings

gene/QTL isolation and development of gene based markers, Allele mining by TILLING and Eco-TILLING, Use of markers in plant breeding.

UNIT IV Marker assisted selection (MAS) in backcross and heterosis breeding, Transgenic breeding, Foreground and background selection; MAS for gene introgression and pyramiding MAS for specific traits with examples.

Suggested Readings

Chittaranjan K. 2006-07 Genome Mapping and Molecular Breeding in Plants Vols. IVII Springer.

Newbury HJ. 2003 Plant Molecular Breeding. Blackwell Publ.

Weising K, Nybom H, Wolff K & Kahl G. 2005. DNA Fingerprinting in Plants Principles, Methods and Applications. Taylor & Francis

MBB 510 BIOSAFETY, IPR AND BIOETHICS 2 (2+0)

Objective: To discuss about various aspects of biosafety regulations, IPR and bioethics concems arising from the commercialization of biotech products

Theory

UNIT I Biosafety and risk assessment issues, Regulatory framework, National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm, Risk management issues - containment.

UNIT II General principles for the laboratory and environmental biosafety. Health aspects, toxicology, allergenicity, antibiotic resistance, etc, Impact on environment gene flow in natural and artificial ecologies, Sources of gene escape, tolerance of target organisms, creation of superweeds/super viruses, etc.

UNIT III Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics, Radiation safety and nonradio isotopic procedure; Benefits of transgenics to human health, society and the environment.

UNIT IV The WTO and other international agreements, Intellectual properties, copyrights. trademarks, trade secrets, patents, geographical indications, etc. Protection of plant variety and farmers right act, Indian patent act and amendments, patent filing. Convention on biological diversity, Implications of intellectual property rights on the commercialization of biotechnology products

Suggested Readings

Singh BD 2007. Biotechnology Expanding Horizon. Kalyani.

MBB 513 NANO-BIOTECHNOLOGY 3 (3-0)

Objective: Understanding the molecular techniques involved in structure and functions of nano- biomolecules in cells such as DNA, RNA and proteins.

Theory

EVS 501: Fundamentals of Environmental Sciences (2+1)

Objective

To make students familiarize with the basic concepts and principles of environmental science, various ecosystems and its relationship with other components.

Theory

Unit 1

Concepts of Environmental Science

Definition, Scope and importance of Environmental studies – Environmental complex-inter relation to other disciplines-History on resource exploitation and conservation.

Unit 2

Ecosystems

Concept of an ecosystem-Ecosystem types and components-Physical, Chemical and Biological character-Structure and function of an ecosystem-Producers, Consumers and decomposers-distribution and abundance of living systems.

Unit 3

Environmental inter relationship and energy Flow

Interrelationship between environment, microbes, plant and animal systems-energy flow and nutrient cycling-food chain, food web and ecological pyramids- Ecological Succession-Ecological interaction and adaptation- periodicity and biological clock.

Unit 4

Environmental Legislation and Policies of the government

Aims and need of Legislation and Policies-Water Act (1974). Air Act (1981), Environmental protection Act (1986) – conservation of forest and wild life. Other major acts related to Solid wastes and Marine pollution.

Unit 5

Global Environmental Issues

Introduction to Environmental issues- Transboundary issues of Environment; Environmental issues in India; Land degradation- Deforestation – Drought – Desertification; of freshwater resources, over exploitation of ground water and Marine pollution – Environmental issues on the construction of big dams

Practical

Population of terrestrial ecosystem, grassland ecosystem – abiotic factors and biotic factors in terrestrial ecosystem- flora and fauna- aquatic ecosystems- biotic and abiotic factors. Forest ecosystem- flora and fauna- biotic factors influencing forest ecosystem. Energy flow and nutrient cycles in the biosphere. Visits to catchment area / dam site, Regulatory bodies, Water boards, Public health departments, Forest and wild life Departments (biosphere reserve areas), Social organizations, Environmental consultancy firms, etc, NGO's and ETP's of established industries.

Suggested Readings

Agarwala, S.P. 2006 Environmental Studies, Narosa Publishing House, New Delhi.

Erach Bharucha 2005. Text book of Environmental Studies. UGC Publication,

University Press Hydrabad

Prabu, P.C., C.Udayasoorian and G.Balasubramanian. 2009. An Introduction to Ecology and

Environmental Science Abhijeet Publications, New Delhi.

Sharma, P.D. 1995. Ecology and Environment. Restogi Publication, Pune

www.ww7b.org/.../Environmental_education_for_the_21st_century.pdf
www.agiweb.org/gap/legis106/neea106.html
https://www.det.nsw.edu.au/.../pd02_49_Environmental_policy.pdf
www.environment.nsw.gov.au/sustainbus/environlegiscompliance.htm
www.dec.wa.gov.au/.../1737-environmental-education-strategy-and-acti.

EVS 502: Instrumental Methods of Environmental Analysis (2+1)

Objective

To impart theoretical and practical knowledge about instrumental techniques used in environmental analysis.

Theory

Unit I

Basic principles of instrumental analysis, principles of electrometric equipments- EC meter, pH meter, ion meter and paleography

Unit II

Spectroscopic techniques used in environmental analysis- UV, visible, flame -emission, absorption, Infra-red, inductively coupled plasma and mass spectrometry

Unit III

Chromatographic techniques in environmental analysis – column, thin layer, gas, high pressure, ion chromatography and electrophoresis

Unit IV

Advanced molecular techniques – Biolog, polymerase chain reaction (PCR)

Unit V

Other techniques of environmental analysis- Kjeltech, particular sampler, infra red gas analyser, BOD and COD kits, fermention technique – fermentor; Free air carbon dioxide enrichment (FACE) and open top chamber (OTC) techniques

Practicals

Determination of pH and EC, Determination of metals and ion using polarographic analyzer; Heavy metal analysis using AAS; Analysis of group I and II metals using flame photometer; Chromatographic analysis; Microbial activity measurement – Biolog and PCR; Determination of N using Kjeltec; Particulate sampling and analysis; Free air carbon dioxide enrichment studies

Suggested Readings

Environmental instrumentation and analysis handbook by Randy D. Down, Jay H. Lehr

Instrumental Methods Of Analysis, by Willard and Merrit Methods for Environmental Trace analysis by John R. Dean Principles of Instrumental Analysis by Douglas A.

EVS 503: Environmental Chemistry & Ecotoxicology (2+1)

Theory

Unit I

Fundamentals of Environmental Chemistry

Stochimetry, Gibb's energy, Chemical potential, Chemicalquilibria, acid-base, reactions. Solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, Radio nuclides. Classification of elements, chemical speciation, particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermo-chemical and photochemical reactions in the atmosphere. First law of thermodynamics, adiabatic transformations, second law of thermodynamics, Carnot's cycle, entropy, third law of thermodynamics, enzymes catalysis, Michaelis/ Menten equation.

Unit II

Atmospheric Chemistry

Structure and composition of atmosphere – Chemical reactions in the atmosphere. Ozone chemistry – CFC's – Acid Rain – Photochemical smog – Aerosols types – production and distribution – Aerosols and Radiation – temperature inversion – Green House gases – Global warming.

Unit III

Water Chemistry

Water resources, hydrological cycle, physical and chemical properties of water, complexation in natural and waste water, role of microorganisms, Water pollutants – Types – Sources – Heavy metals – Metalloids – Organic – Inorganic – Biological and Radioactive – Types of reactions in various water bodies including marine environment – Eutrophication – Groundwater – Potable water chemistry applications in waste water treatment methods: Coagulation oxidation – H_2O_2, fenton, ozontion, sonication- ion exchange – adsorption membrane filtration.

Unit IV

Soil Chemistry and Green Chemistry

Organic and inorganic – soil, physical and chemical properties – Cation exchange capacity – soil pH – Environmental properties of soils: Leaching and erosion – reactions with acids and bases – Geochemical reactions that neutralize acidity – Biological Process that neutralize acidity – salt affected soil – Trace metals in soils. Principles – tools of Alternative feed stocks starting material alternative reagents, alternative solvents, alternative products and alternative catalysis. Green Environmental issues : Introduction – Ecological and Carbon foot print – Carbon Credits – Carbon Sequestration – Clean Development mechanism (CDM) – Polluters pay – Consumerism – Sustainable mining – Urban forestry –

Green buildings – Green building practices – Approaches to green computing – Nanotechnology and Environment.

Unit V

Introduction to Ecotoxicology

Definition, classification of toxicants in environment, factors affecting toxicity, Mutagenesis, Teratogenesis, Carcinogens, Hallucinogens; Phytotoxins and animal toxins; Toxic response of different body system likes respiratory, gastro-intestinal tract, liver, kidney, immune system and reproductive system; Toxicants types; Absorption and distribution of toxicants in animal body' Bio-transformation of toxicants; Antidotes treatment and detoxification of toxicants; Bio-accumulation Toxic chemicals in the environment – air, water and their effects, Pesticides in water, mode of entry of toxic substance, biotransformation of xenobiotics detoxification, Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Environmental carcinogenicity testing. Toxicants – Dose response relationship – Evaluation methods – LD50 and LC50, MIC and IC50 Dose. Impact of toxic chemicals on Enzymes-Biochemical effects of arsenic, lead, carbon monoxide, Nitrogen oxides, Sulphur dioxide, ozone, PAN, cyanide, pesticides and Carcinogens.

Practicals

Sample preparation – Collection, processing, storage of effluents, sludge, water, soil and plant samples, Estimation of heavy metals (Chromium Lead) in environmental samples, Adsorption/ desorption of pesticides/ herbicides and heavy metals in soil' Determination of air pollutants – NH3, CO2, SO2, N2O – sampling methods and measurements; Estimation of toxic pesticides in soil, crop and water, Fertilizer residues in soil.

Suggested Readings

Andrew, D. Eaton, Lenore. S., Clesceri and W. Eugene and Arnold Greenberg 2005. Standard Methods for Examination of Water and Wasterwater. APHA (USA).

Connell, D.W. 1997. Basic Concepts of Environmental Chemistry. Springer Publication, The Netherlands.

De. A.K. 1992. Environmental Chemistry. Wiley Eastern Ltd., New Delhi.

Ming Ho Yu, H.Tsunoda 2011. Environmental toxicity : Biological and health effects of pollutants. Third edition, CRC press, London, New York PP-1-375.

Willian Harwitz, George and W. Latimer 2005. Official Methods of Analysis published by Association of Officiating Analytical Chemists (AOAC) USA.

e-Resources

http://www.publish.csiro.au

http://www.oficyna.pwr.wroc.pl, oficwyd@pwr.wroc.pl

http:// www. books.pakchem.net/fundamentals-of-environmental-chemistry.html

http:// www .books.pakchem.net/elements-of-environmental-chemistry.html.

http:// www .books.pakchem.net/elements-of-environmental-chemistry.html.

http://www.taylorandfrancis.com

EVS 504: Solid Waste Management (1+1)

Objective

This course deals with different types of solid waste available their characteristics, management techniques, and environmental impact. The infrastructure facilities required for solid waste management, legislation to monitor the program and quality control aspects of this program are all covered in this course.

Theory

Unit I

Availability of different types of solid waste from different sources – its overall characteristics – classification of solid wasters based on their characteristics.

Unit II

Basic techniques in solid waste management program – composting – vermicomposting – energy production – value products – safe disposal of rejected materials.

Unit III

Infrastructure requirement for different solid waste management techniques- machineries involved – management unit plan and financial commitment.

Unit IV

Quality control measures for the product derived from solid waste management – Legislation to monitor solid waste program – Organization involved to monitor the solid waste management program.

Unit V

Legislation in solid waste management – Pollution control board norms – Responsibility of waste generators – impact of solid waste management on environment.

Practicals

Collection of different types of wastes – study the characteristics of waste – composting of biodegradable waste into organic manure and vermicompost – Estimation of nutrient content in the manure – Converting high calorie waste into energy – methane production – Briquette formation – estimation of calorie value – value products – brick making from fly ash – banana fiber extraction from banana waste – Project report preparation for solid waste management program – visit to secured land filling unit – visit to solid waste management unit – Visit to quality control laboratory.

Suggested Readings

Diaz, I.F., M. de Bertoldi and W. Bidlingmaier 2007. Compsot science and technology, Elsevier pub., PP. 1-380.

Hammer, M.J. and M.J. Hammer Jr. 2003. Waste and Waste water Treatment Technology, Prentice Hall of India Pvt. Ltd.

Prabhakar, V.K. 2001. Solid Waste Management. Anmol Pub Pvt. Ltd., New Delhi, PP 286.

Uta Krogmann, Ina Kome and Luis F. Diaz 2010. Solid waste technology and management (Vo. 1 and 2). Blackwel Pub. Ltd. Wiley Online library.

e-Resources

http://www.ec.europa.eu/environment/water/water-urbanwaste/index_en.html

http://www.gewater.com/wastewater-treatment.html

http://www.printsasia.in/book/solid-waste-management-v-k-prabhakar 8126109300-

EVS 505: Waste Water Management (2+1)

Objective

To make the students familiarize with various technologies available for managing the waste water and it's recycling

Theory

Unit I

Water resources and its contamination

Introduction to water resources – Drinking water – water quality in flowing water- impounded waters and ground water quality – Water quality standards – microbiological and chemical quality of drinking water – Characterizations of domestic – industrial – infiltration and inflow and municipal waste water – Wastewater flows, sampling, monitoring and evaluation of waste water.

Unit II

Waste water biology and processing of waste water

Microbiology of waste water and waterborne diseases – Biological treatment systems and biological kinetics- Physical – chemical – biological processing of water.

Unit III

Sewage and industrial waste water

Sewage systems and sewage characteristics – Waste water treatment methods – Types of industrial wastes – sludge treatment and disposal – Microbial metabolism, growth kinetics, aeration and agitation – Bioreactors for waste water treatment – waste water economics – Biotechnology and hazardous waste removal.

Unit IV

Wastewater treatment

Microbiology and bioremediation of waste water treatment- aerobic / anaerobic – energy production – Limitations in conventional treatment – Advanced treatment technologies – Membrane technology – Reed bed systems – Biological nutrient removal.

Unit V

Recycling of wastewater

Monitoring the Quality of treated wastewater – Management options for utilization of treated wastewater for agriculture – Groundwater recharge.

Practicals

Sampling methods – Physical and chemical properties of water and waste water- Biological properties of wastewater – coliforms assay in water and wastewater – Aeration and activated sludge treatment of wastewater – Biomethanation potential of wastewater and microbial

communities in waste water treatment system – Visit to sewage treatment plants- Visit to industrial waste treatment plant and biomethanation plants- Practical examination.

Suggested Readings

Arceivala, S.J. 2000. Wastewater Treatment for Pollution Control, Second Edition, TMH, New Delhi.

Drinan, J.E. and Spellman, F.R. 2012. Water and Waste water Treatment. A Guide for the Nonengineering Professional, Second Edition, CRC Press.

Goel, P.K. 2003. Advances in Industrial Wastewater Treatment. ADH Publishers, India.

Metcalf and Eddy, INC, Waterwater Engineering – Treatment and Reuse, Fourth Edition, Tata Mc Graw-Hill Publishing company Limited, New Delhi 2003.

Cheremisinoff, N.P. 2002. Handbook of water and wastewater Treatment Technologies, Butterworth Helnemann, Melboume.

Hammer, M.J, and M.J. Hammer Jr. 2003. Waste and Waste water Treatment Technology, Prentice Hall of India Pvt. Ltd.

Spellmam, F.R. 2003. Handbook of water and wastewater Treatment plant operation. Lewis Publisher, ACRC Press Company London.

Udo Wiesmann, In Suchoi, and E.M.Donbrooski 2007. Fundamentals of Biological wastewater treatment. Wiley – VCH Verlage GmbH and co., KGaA, Weinheim

e-Resources

http://www.water.uses.gov/edu/wuww.html
http://www.ge.com/in/water
http://www.fao.org/docrep/t0551e/t0551e05.htm
http://www.waterworld.com/waste-water.html

http://www.unwater.org/activities/task-forces/wastewater-management/en
http://www.epa.gov./rpdweb00/tenorm/water-treatment.html
http://www.ibwc.stage.gov/Organization/Operations/Field_Officers/Nogales.html
http://www.ec.europa.eu/environment/water/water-urbanwaste/index_en.html
http://www.gewater.com/wastewater-treatment.html
http://www.thermaxindia.com/water-and-waste-solutions/systems-and-solutions/industrial-effluent-treatment-and-recycling.aspx

EVS 507: Biodiversity & Conservation (1+1)

Objective

To provide a comprehensive knowledge on biodiversity, loss of biodiversity and conservation methods.

Theory

Unit I

Biodiversity and its importance

Biodiversity: Definition, Elements of Biodiversity, measuring biodiversity, Global distribution of flora and fauna, Values of biodiversity, Geographical diversity- Mapping biodiversity, Species-Area relationships; Mega Diversity Regions, Biodiversity Hot Spots, India's Biodiversity.

Unit II

Speciation and Extinction

Concepts of speciation- Anagenesis and cladogenesis –Patterns of Species Biodiversity. Theories on biodiversity – Ecological Niche, Keystone Species, 'K' and 'R' Strategists Species, Immigrant and

Indicator Species, New Ecosystems, Endemism and Exotic Species. Historical extinction episodes- Evolution- Natural selection- Adaptive Radiation Causes and processes of extinction-Extinction in India.

Unit III

Agro- Biodiversity

Agro-Biodiversity- Microbial Biodiversity- Conceptual View and General Benefits- Agricultural Development and Biodiversity Links- Agro-Biodiversity Loss; Conflicts and Effects- Causes of Biodiversity losses linked to Agriculture Diversity through Sustainable Agriculture.

Unit IV

Conservation of Biodiversity

Conservation Methods- Protected Areas- Protected Areas Network In India- National parks and Wildlife Corridors- Biosphere Reserves- MAB- World Heritage-Biosphere Reserves In India- On-Fann and Home Garden Conservation Ex-Stnt Conservation- Tissue Culture and Germplasm Storage- Captive breeding and Reintroduction. Special projects for endangered wildlife- Conservation Plans in India- Sacred Groves.

Unit V

Convention on Biological Diversity

The Convention on Biological Diversity and milstones- CTTES- Free Trade and the Environment – WTO, The Ramsar Convention- IUCN Red List- India's Participation in the International Programmes- biodiversity act.

Practical

Measurement of biotic factors in the terrestrial eco-system- Quadrat method- minimum size of a Quadrat- minimum number of Quadrats- Frequency, abundance and density of plant species in terrestrial eco-system-Determination of biodiversity indices of plant

species in terrestrial ecosystem- Line transect method- Belt transect method- Point frame method- Plotless sampling methods- Population size of invertibrates in terrestrial eco-system by mark and recapture methods –Assessment of Earthworm-Microbial diversity in terrestrial and aquatic eco-system- study of planktons in aquatic ecosystem.- Tissue culture and cryopreservation techniques for the conservation of biodiversity – Study tour to a wild life sanctuary (biosphere reserve). Indian Hot spot and polluted habitat.

Suggested Readings

Bhatti J.S. R.Lal, M.J. Apps and M.A.Price. 2007. Climate change and managed ecosystems, CRC Taylor and Francies, Newyork and London. PP. 1-446.

Dutta, A., S.Dutta and P.N. Pandey. 2005.Environmental Issues and Challenges, A.P.H. Pub. Corp. New Delhi. pp.1-351.

Gaston, K.J. and J.J. Spicer. 1998. Biodiversity: An Introduction. Blackwell Science Limited New York.

Magwaran. A.E. 1988. Ecological Diversity and its Measurement Croom Helm, London 167pp. Pullaiah,. T. 2011. Biodiversity in India Regency Publication

Singh. R.B. 2009. Biodiversity and Environment. Rawat Publications Wilson, D.E. and F.M.

Peter. 1988. Biodiversity. National Academy Press, Washington. 520pp.

World Convention Monitoring Centre (1992) Global Biodiversity: Status of Earth's Living

Resources. Chapman and Hall London.

e-Resources

http://www.nap.edu/catalog/989.html

http://indianbiodiversitytalk.blogspot.in/p/downloads.html

EVS 508: Global climate Change and Agriculture

Objective

To impart theoretical and practical knowledge about the evidence, causes and impact of climate change and its adaptation and mitigation options

Theory

Unit I

Definition and concept of climate change and variability; global warming and dimming; science and politics of climate change and international conventions; evidence, scenario and causes of climate change

Unit II

Greenhouse gases and mechanism of their production and emission from various agro-ecosystems, source and sinks of GHG; warming potential and contribution of greenhouse gases to global warming, greenhouse effect; monitoring of greenhouse gases

Unit III

Impact assessment of rise in atmospheric temperature and CO_2 on growth, physiological processes, productivity and quality of different crops, soil health, water availability, insect pest dynamics, crop-weed competition, milk and inland and marine fish production; climate change and loss of biodiversity; spatial and temporal changes in agricultural production in context of climate change.

Unit IV

Evidence and causes of global dimming; causes of global dimming; impact assessment of global dimming on crop productivity, quality and crop- pest interaction.

Unit V

Adaptation and mitigation options to climate change; carbon sequestration; modeling climate change and its impact on crops; International summit, conferences, protocols and negotiations on climate change; clean development mechanism; carbon trading, credits, footprints and govt. strategies and policies on climate change management.

Practicals

Measurement of CO_2 from crop fields, Measurement of CH_4 from crop fields, Measurement of N_2O from crop fields, Measurement of O_3 from crop fields, Recent techniques for assessing the impact of high temperature on crops, Recent techniques for assessing the impact of CO_2 fertilization on crops, Recent techniques for assessing the impact of elevated O_3 on crops, Modelling impact of high temperature and CO_2 on crop yield, Modelling impact of high temperature on soil and water, Modelling impact of high CO_2 on soil and water

Suggested Reading

Climate change and global crop productivity ed. by K.R. Reddy and H.F. Hodges, CABI Publishing

Climate change Journal

Climate Change: Source, impact and policy, Proceeding of 2nd World Climate Conference. Ed. by J. Jager and H.L. Ferguson, Cambridge University Press, 1993

Global Warming (Fourth edition) by John Houghton, Cambridge Press

Greenhouse gas emission from agricultural system, Published by IPCC- USEPA IPCC Assessment Report 2007

EVS 511: Environmental Monitoring Systems and Impact Assessment (1+1)

Objective

To help the students acquire fundamental knowledge on environmental impact assessment and its importance in environmental protection.

Theory

Unit I

Concept of environmental impact assessment

Types of environmental impacts – natural impacts – impacts due to developmental activities.

Unit II

Methods of EIA

Economic, environmental and ecological consequences of common property ecosystem degradation.

Unit III

Current status of EIA

EIA in developed countries – steps and processes in EIA study – predication and assessment of different environments – soil, air, water, noise – biological, socioeconomic and cultural appraisal of EIA.

Unit IV

Economic development

Concept, trend and dimension. Criteria for evaluating environment related projects – review of EIA – status of EIA in India.

Unit V

Case studies for EIA

Conflict between industrialization and environmental preservation – effect of global trade on environment – role of Government in resource and natural management**.**

Practicals

Defining the problem in different ecosystems – quarry mining – coastal catchment ecosystem – deforestation – industrial conservation – highways – study on physical, chemical and biological properties – EIA: assessing the economic loss due to land, water and resources degradation – visit to coal mine area – industrial area and silent valley – management aspects of EIA.

Suggested Readings

Basile, R.M. 1971. In: Conservation of Natural Resources (Ed. G.H.Smith). John Wiley and sons, New York. 133.

Munn, R.E.1975. Environmental Impact Assessment: Principles and Procedures. Scope report 5. Coronto, Canada.

Royston, M. 1978. In: Managing the Environment (eds. D.Bandhu, V.Bhardwaj and J.C.Bhat).
IES, New Delhi.

Sembrook, J. and D.W. 2011. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3.

e-Resources

http://web.pdx.edu/~maserj/ESR 429_529/ESR 429-529.htm
http://www.naep.org/mc/page.do?sitepageId=91299andorgId=naep
http://www.sasanet.org/documents/tools/social impact assessment methodology.pdf
http://www.snh.gov./ebooks/A1198363 EIA handbok.pdfuk

EVS 513: Agroforestry (2+0)

Objectives

To give an overview to the students on the importance of agroforestry in agriculture and environment

Theory

Unit I

Agroforestry- its definition, concept, scope and advantage; classification of agroforestry; selection of plant species; plant species interaction; growth & production of tree plant; agroforestry & resource utilization

Unit II

Agroforestry models for various land use systems; agri-silviculture system, silvi-agrivulture system, silvi-pasture system, agri-silvi-pasture system, regeneration of tree crops

Unit III

Agroforestry options for sustainable land use; relationships between agro forestry, farm forestry and social forestry; agroforestry research in agricultural research system; environmental education as a tool for sustainable agroforestry

Unit IV

Agroforestry, biodiversity and sustainability; carbon sequestration through agroforestry; techniques to improve biomass production and climate change mitigation; biofuel production; agroforestry and sustainability

Unit V

Natural resources and environment management through ecosystem approach; biotic and abiotic components of ecosystem and their linkages; economics of agroforestry system

Suggested Readings

A Text book of Agroforestry by B.S.Chandawat and S.K.Gautam

Agroforestry: Principles and Practices by A.P. Dwivedi

Advances in Agrforestry by L.K. Jha

Agrforestry for Sustainable Land Use by P.Singh, P.S.Pathak and M.M. Roy

Environmental Services of Agroforestry Systems by Florencia Montagnini

Handbook on Agroforestry: Management Practices and Environmental Impact by Lawrence R. Kellimore (Editor)

Potential Application of Agroforestry System from Indian Subcontinent to the Analogous Ecozones of Africa by G.B. Singh (ICAR).

Note : For minor courses please refer the concerned department's courses outline.

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

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

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

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

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

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

Theory

UNIT I

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

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics. UNIT III Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Cooperatives, Voluntary Agencies/Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.

Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

PGS 506 DISASTER MANAGEMENT 1+0 (e-Course)

Objectives To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters - Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: Global warming, Sea level rise, Ozone depletion.

UNIT II

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

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

AGRONOMY

Course Title : Modern Concepts in Crop Production

Course Code :Agron 501

Credit Hours : 3+0

Aim of the course : To teach the basic concepts of soil management and crop production.

Theory

Unit I

Crop growth analysis in relation to environment; geo-ecological zones of India.

Unit II

Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.

Unit III

Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

Unit IV

Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress, use of growth hormones and regulators for better adaptation in stressed condition.

Unit V

Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture.Modern crop production concepts: soil less cultivation, Aeroponic, Hydroponic, Robotic and terrace farming. use of GIS, GPS and remote sensing in modern agriculture, precision farming and protected agriculture.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, assignment and class discussion

Learning outcome

Basic knowledge on soil management and crop production

Suggested Reading

- Balasubramaniyan P and Palaniappan SP. 2001. *Principles and Practices of Agronomy*. Agrobios.
- Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.
- Havlin JL, Beaton JD, Tisdale SL and Nelson WL. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.
- Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.
- Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publ.
- Sankaran S and Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.
- Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.
- Alvin PT and kozlowski TT (ed.). 1976. *Ecophysiology of Tropical Crops*. Academia Pul., New York.
- Gardner PP, Pearce GR and Mitchell RL. 1985. *Physiology of Crop Plants*. Scientific Pub. Jodhpur.
- Lal R. 1989. Conservation tillage for sustainable agriculture: Tropics versus Temperate Environments. *Advances in Agronomy* 42: 85-197.
- Wilsie CP. 1961. *Crop Adaptation and Distribution*. Euresia Pub., New Delhi.

Course Title : Principal and Practices of Soil Fertility and Nutrient Management

Course Code :Agron 502

Credit Hours : 2+1

Aim of the course : To impart knowledge of fertilizers and manures as sources of plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil fertility.

Theory

Unit I

Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.

Unit II

Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

Unit III

Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management. Soil less cultivation.

Unit IV

Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency; agronomic, chemical and physiological, fertilizer mixtures and grades; methods of increasing fertilizer use efficiency; nutrient interactions.

Unit V

Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic nutrients;

economics of fertilizer use; integrated nutrient management; use of vermincompost and residue wastes in crops.

Practical

- Determination of soil pH and soil EC
- Determination of soil organic C
- Determination of available N, P, K and S of soil
- Determination of total N, P, K and S of soil
- Determination of total N, P, K, S in plant
- Computation of optimum and economic yield

Teaching methods/activities

Classroom teaching with AV aids, group discussion, assignment and class discussion

Learning outcome

Basic knowledge on soil fertility and management

Suggested Reading

- Brady NC and Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- Fageria NK, Baligar VC and Jones CA. 1991. *Growth and Mineral Nutrition of Field Crops*. Marcel Dekker.
- Havlin JL, Beaton JD, Tisdale SL and Nelson WL. 2006. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall.
- Prasad R and Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
- Yawalkar KS, Agrawal JP and Bokde S. 2000. *Manures and Fertilizers*. Agri-Horti Publ.

Course Title : Principles and Practices of Weed Management

Course Code :Agron 503

Credit Hours : 2+1

Aim of the course : To familiarize the students about the weeds, herbicides and methods of weed control.

Theory

Unit I

Weed biology, and ecology and classification, crop-weed competition including allelopathy; principles and methods of weed control and classification management; weed indices, weed shift in different eco-systems

Unit II

Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.

Unit III

Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures, sequential application of herbicides, rotation; weed control through use ofnano-herbicides and bio-herbicides, myco-herbicides bio-agents, and allelochemicals; movement of herbicides in soil and plant, Degradation of herbicides in soil and plants; herbicide resistance, residue, persistence and management; development of herbicide resistance in weeds and crops and their management, herbicide combinationand rotation.

Unit IV

Weed management in major crops and cropping systems; alien, invasive and parasitic weeds and their management; weed shifts in cropping systems; aquatic and perennial weed control; weed control in non-crop area.

Unit V

Integrated weed management; recent development in weed management-robotics, use of drones and aeroplanes, organic etc., cost: benefit analysis of weed management.

Practical

• Identification of important weeds of different crops, Preparation of a weed herbarium, Weed survey in crops and cropping systems, Crop-weed

competition studies, Weed indices calculation and interpretation with data, Preparation of spray solutions of herbicides for high and low-volume sprayers, Use of various types of spray pumps and nozzles and calculation of swath width, Economics of weed control, Herbicide resistance analysis in plant and soil,

- Bioassay of herbicide resistance residues,
- Calculation of herbicidal herbicide requirement

Teaching methods/activities

Classroom teaching with AV aids, group discussion, field visit to identify weeds.

Learning outcome

Basic knowledge on weed identification and control for crop production

Suggested Reading

- Böger, Peter, Wakabayashi, Ko, Hirai, Kenji (Eds.). 2002. Herbicide Classes in Development. Mode of Action, Targets, Genetic Engineering, Chemistry. Springer.
- Chauhan B and Mahajan G. 2014. Recent Advances in Weed Management. Springer.
- Das TK. 2008. Weed Science: Basics and Applications, Jain Brothers (New Delhi).
- Fennimore, Steven A and Bell, Carl. 2014. Principles of Weed Control, 4th Ed, California Weed Sci. Soc.
- Gupta OP. 2007. Weed Management: Principles and Practices, 2nd Ed.
- Jugulan, Mithila (ed). 2017. Biology, Physiology and Molecular Biology of Weeds. CRC Press
- Monaco TJ, Weller SC and Ashton FM. 2014. Weed Science Principles and Practices, Wiley
- Powles SB and Shaner DL. 2001. Herbicide Resistance and World Grains, CRC Press.
- Walia US. 2006. Weed Management, Kalyani.
- Zimdahl RL. (ed). 2018. Integrated Weed Management for Sustainable Agriculture, B. D. Sci. Pub.

Course Title : Principles and Practices of Water Management

Course Code :Agron 504

Credit Hours : 2+1

Aim of the course : To teach the principles of water management and practices to enhance the water productivity

Theory

Unit I

Water and its role in plants; Irrigation: Definition and objectives, water resources and irrigation development in India and concerned state, major irrigation projects, extent of area and crops irrigated in India and in different states.

Unit II

Field water cycle, water movement in soil and plants; transpiration; soil-waterplant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition. Water availability and its relationship with nutrient availability and losses.

Unit III

Soil, plant and meteorological factors determining water needs of crops, scheduling, depth and methods of irrigation; micro irrigation systems; deficit irrigation; fertigation; management of water in controlled environments and polyhouses. Irrigation efficiency and water use efficiency.

Unit IV

Water management of crop and cropping system, Quality of irrigation water and management of saline water for irrigation, water use efficiency, Crop water requirement- estimation of ET and effective rainfall; Water management of the major crops and cropping systems. Automated irrigation system.

Unit V

Excess of soil water and plant growth; water management in problem soils, drainage requirement of crops and methods of field drainage, their

layout and spacing; rain water management and its utilization for crop production.

Unit VI

Quality of irrigation water and management of saline water for irrigation, water management in problem soils

Unit VII

Soil moisture conservation, water harvesting, rain water management and its utilization for crop production.

Unit VIII

Hydroponics,

Unit IX

Water management of crops under climate change scenario.

Practical

- Determination of Field capacity by field method
- Determination of Permanent Wilting Point by sunflower pot culture technique
- Determination of Field capacity and Permanent Wilting Point by Pressure Plate Apparatus
- Determination of Hygroscopic Coefficient
- Determination of maximum water holding capacity of soil
- Measurement of matric potential using gauge and mercury type tensiometer
- Determination of soil-moisture characteristics curves
- Determination of saturated hydraulic conductivity by constant and falling head method
- Determination of hydraulic conductivity of saturated soil below the water table by auger hole method
- Measurement of soil water diffusivity
- Estimation of unsaturated hydraulic conductivity.

Estimation of upward flux of water using tensiometer and from depth ground water table

- Determination of irrigation requirement of crops (calculations)
- Determination of effective rainfall (calculations)
- Determination of ET of crops by soil moisture depletion method
- Determination of water requirements of crops
- Measurement of irrigation water by volume and velocity-area method
- Measurement of irrigation water by measuring devices and calculation of irrigation efficiency
- Determination of infiltration rate by double ring infiltrometer

Teaching methods/activities

Classroom teaching with AV aids, group discussion, assignment and field visit

Learning outcome

Basic knowledge on water management for optimization of crop yield

Suggested Reading

- Majumdar DK. 2014. Irrigation Water Management: Principles and Practice. PHL Learning private publishers
- Mukund Joshi. 2013. A Text Book of Irrigation and Water Management Hardcover, Kalyani publishers
- Lenka D. 1999. Irrigation and Drainage. Kalyani.
- Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.
- Paliwal KV. 1972. Irrigation with Saline Water. IARI Monograph, New Delhi. • Panda SC. 2003. Principles and Practices of Water Management. Agrobios.
- Prihar SS and Sandhu BS. 1987. Irrigation of Food Crops - Principles and Practices. ICAR.
- Reddy SR. 2000. Principles of Crop Production. Kalyani.
- Singh Pratap and Maliwal PL. 2005. Technologies for Food Security and Sustainable Agriculture. Agrotech Publ.

Course Title : Cropping Systems and Sustainable Agriculture

Course Code :Agron 511

Credit Hours : 2+0

Aim of the course : To acquaint the students about prevailing cropping systems in the country and practices to improve their productivity.

Theory

Unit I

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

Unit II

Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

Unit III

Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

Unit IV

Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system. Advanced nutritional tools for big data analysis and interpretation.

Unit V

Plant ideotypes for drylands; plant growth regulators and their role in sustainability.

Unit VI

Artificial Intelligence- Concept and application.

VII. Teaching methods/ activities

Classroom teaching with AV aids, group discussion, assignment.

VIII. Learning outcome

Basic knowledge on cropping system for sustainable agriculture.

IX. Suggested Reading

• Panda SC. 2017. Cropping Systems and Sustainable Agriculture. Agrobios (India)
• Panda SC. 2018. Cropping and Farming Systems. Agrobios.
• Palaniappan SP and Sivaraman K. 1996. Cropping Systems in the Tropics; Principles and Management. New Age.
• Panda SC. 2003. Cropping and Farming Systems. Agrobios.
• Reddy SR. 2000. Principles of Crop Production. Kalyani.
• Sankaran S and Mudaliar TVS. 1997. Principles of Agronomy. The Bangalore Printing & Publ. Co.
• Singh SS. 2006. Principles and Practices of Agronomy. Kalyani
• Tisdale SL, Nelson WL, Beaton JD and Havlin JL. 1997. Soil Fertility and Fertilizers. Prentice Hall.

Course Title : Dryland Farming and Watershed Management

Course Code. :Agron 512

Credit Hours : 2+1

Aim of the course : To teach the basic concepts and practices of dry land farming and soil moisture conservation.

Theory

Unit I

Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture.

Unit II

Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.

Unit III

Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.

Unit IV

Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); antitranspirants; soil and crop management techniques, seeding and efficient fertilizer use.

Unit V

Concept of watershed resource management, problems, approach and components.

Practical

- Method of Seed Priming
- Determination of moisture content of germination of important dryland crops
- Determination of Relative Water Content and Saturation Deficit of Leaf
- Moisture stress effects and recovery behaviour of important crops
- Estimation of Potential ET by Thornthwaite method
- Estimation of Reference ET by Penman Monteith Method
- Classification of climate by Thornthwaite method (based on moisture index, humidity index and aridity index)
- Classification of climate by Koppen Method

- Estimation of water balance by Thornthwaite method
- Estimation of water balance by FAO method
- Assessment of drought
- Estimation of length of growing period
- Estimation of probability of rain and crop planning for different drought condition
- Spray of anti-transpirants and their effect on crops
- Water use efficiency
- Visit to dryland research stations and watershed projects

Teaching methods/activities

Classroom teaching with AV aids, group discussion, assignment.

Learning outcome

Basic knowledge on dry land farming and soil moisture conservation.

Suggested Reading

- Reddy TY. 2018. Dryland Agriculture Principles and Practices, Kalyani publishers
- Das NR. 2007. Tillage and Crop Production. Scientific Publ.
- Dhopte AM. 2002. Agrotechnology for Dryland Farming. Scientific Publ.
- Dhruv Narayan VV. 2002. Soil and Water Conservation Research in India. ICAR.
- Gupta US. (Ed.). 1995. Production and Improvements of Crops forDrylands. Oxford & IBH.
- Katyal JC and Farrington J. 1995. Research for Rainfed Farming. CRIDA.
- Rao SC and Ryan J. 2007. Challenges and Strategies of Dryland Agriculture. Scientific Publ.
- Singh P and Maliwal PL. 2005. Technologies for Food Security and Sustainable Agriculture. Agrotech Publ. Company.
- Singh RP. 1988. Improved Agronomic Practices for Dryland Crops. CRIDA.
- Singh RP. 2005. Sustainable Development of Dryland Agriculture in India. Scientific Publ.
- Singh SD. 1998. Arid Land Irrigation and Ecological Management. Scientific Publ.

• Venkateshwarlu J. 2004. Rainfed Agriculture in India. Research and Development Scenario. ICAR.

Course Title : Principles and Practices of Organic Farming

Course Code :Agron 513

Credit Hours : 2+1

Aim of the course : To study the principles and practices of organic farming for sustainable crop production.

Theory

Unit I

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; principles of organic agriculture; organics and farming standards; organic farming and sustainable agriculture; selection and conversion of land, soil and water management - land use, conservation tillage; shelter zones, hedges, pasture management, agro-forestry.

Unit II

Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures, bio-fertilizers and biogas technology.

Unit III

Farming systems, selection of crops andcrop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

Unit IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, bio-pesticides.

Unit V

Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practical

- Method of making compost by aerobic method
- Method of making compost by anaerobic method
- Method of making vermicompost
- Identification and nursery raising of important agro-forestry trees and trees for shelter belts
- Efficient use of biofertilizers, technique of treating legume seeds with Rhizobium cultures, use of Azotobacter, Azospirillum, and PSB cultures in field
- Visit to a biogas plant
- Visit to an organic farm
- Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

Teaching methods/activities

Classroom teaching with AV aids, group discussion, assignment. exposure visit

Learning outcome

Basic knowledge on organic farming for sustainable agriculture and development of entrepreneurship on organic inputs.

Suggested Reading

- Ananthakrishnan TN. (Ed.). 1992. Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH.
- Gaur AC. 1982. A Manual of Rural Composting, FAO/UNDP Regional Project Document, FAO.
- Joshi M. 2016. New Vistas of Organic Farming. Scientific Publishers
- Lampin N. 1990. Organic Farming. Press Books, lpswitch, UK.
- Palaniappan SP and Anandurai K. 1999. Organic Farming – Theory and Practice. Scientific Publ.

firms. In addition to this the students are also given knowledge about the research developments in the subject. The approach is analytic.

Organization of the course
The course is organised as follows:

No	Block	Unit
1	Introduction to Agricultural Finance	1. Basic Concepts: A review
2.	Credit and financial analysis	1. Credit and its aspects
		2. Financial analysis
3	Project and risk management	1. Project Overview
		2. Risk and its Management

Theory Block 1: Introduction to Agricultural Finance

Unit 1: Basic concepts: A Review

Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Direct and Indirect Financing - Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's - NGO's, and SHG's.

Block 2: Credit and Financial Analysis

Unit 1: Credit and its aspects

Lending to farmers – The concept of 3 C's, 7 P's and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.

Unit 2: Financial analysis

Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/ firm.

Block 3- Project and Risk Management

Unit 1: Project Overview Project

Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques –

Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Net work Techniques – PERT and CPM.

Unit 2: Risk and its Management

Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes – review of different crop insurance schemes - yield loss and weather based insurance and their applications.

Practical

• Development of Rural Institutional Lending;

Branch expansion, demand and supply of institutional agricultural credit and Over dues and Loan waiving;

• An overview, Rural Lending Programmes of Commercial Banks, Lead Bank Scheme;

• Preparation of District Credit Plan, Rural Lending Programmes of Co-operative Lending Institutions;

• Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements;

• Performance of Micro Financing Institutions;

• NGO's and Self-Help Groups, Identification and formulation of investment projects;

• Project appraisal techniques – Undiscounted Measures and their limitations;

• Project appraisal techniques – Discounted Measures;

• Network techniques – PERT and CPM for project management;

• Case Study Analysis of an Agricultural project;

• Financial Risk and risk management strategies – crop insurance schemes;

• Financial instruments and methods – E banking, Kisan Cards and core banking.

IX. Teaching Methods/ Activities

• Lectures

• Case studies

• Assignments (Group/individual)

• Group Discussions on inflation

Learning outcome

After the completion of the course the student will be able to-Understand the key issues of finance in Agriculture. Learn the techniques of assessing the worth of a project.

Suggested Reading

• E Die Sollem H and Heady EO. (Ed.). Capital and Credit Needs in Changing Agriculture, Bauman.
• Hopkins A Barry, Peter Jo and Baker CB. Financial Management in Agriculture.
• Murray WG and Nelson AG. 1960. Agricultural Finance. Iowa State University
• Chanona C. 1969. Agricultural Finance in India: Role of Commercial Banks. Marketing and Economics Research Bureau, New Delhi.
• Gittinger JP. 1972. Economic analysis of agricultural projects, John Hopkins Univ. Press, Baltimore.
• Little IMD and JA Mirrless. 1974, Project appraisal and planning for developing countries, Oxford and IBH publishing Co. New Delhi.
• Arnold CH. 1972. Project Evaluation, collected papers, Macmillan.

Course Title : Linear Programming

Course Code : AEC-508

Credit Hours : 1+1

Theory

Unit I

Decision Making- Concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of LP in different fields, graphic solution to problems, formulation of problems.

Unit II

Simplex Method: Concept of simplex Method, solving profit maximization and cost minimizations problems. Formulation of farms and non farm problems as linear programming models and solutions.

Unit III

Extension of Linear Programming models: Variable resource and price programming, transportation problems, recursive programming, dynamic programming.

Unit IV

Teaching methods

• Power point presentation

• Chalk and Board • Smart board

• Lectures • Assignments, quiz

• Group tasks, student's presentations

Learning outcome

After passing out this course the student will be able to know the difference between the genotype and phenotype, can carry study on inheritance and also know the role of DNA and RNA in genotypic manifestation of characters.

Suggested reading

Daniel LH and Maryellen R. 2011. Genetics: "Analysis of Genes and Genomes". Gardner EJ and Snustad DP. 1991. Principles of Genetics. John Wiley and Sons. 8th ed. 2006 Klug WS and Cummings MR. 2003. Concepts of Genetics. Peterson Edu. Pearson Education India; Tenth edition Lewin B. 2008. Genes XII. Jones and Bartlett Publ. (International Edition) Paperback, 2018 Russell PJ. 1998. Genetics. The Benzamin/ Cummings Publ. Co Singh BD. 2009. Genetics. Kalyani Publishers (2nd Revised Edition) Snustad DP and Simmons MJ. 2006. Genetics. 4th Ed. John Wiley and Sons. 6th Edition International Student Version edition Stansfield WD.1991. Genetics.Schaum Outline Series Mc Graw Hill Strickberger MW. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India; 3rd ed., 2015 Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs., McGraw Hill Education; 7 edition Uppal S, Yadav R, Singh S and Saharan RP. 2005. Practical Manual on Basic and Applied Genetics. Dept. of Genetics, CCS HAU Hisar.

Course Title : Principles of Plant Breeding*

Course Code : GPB 502

Credit Hours : 3(2+1)

Why this course?

Development of plant variety is the ultimate aim of any plant breeding program. A post graduate in the subject of agriculture must know what are the different selection methods, techniques and related crop improvement strategies. Further, knowledge of genetic resources, evolution and their role in development of noble varieties is the need of the hour. Plant Sciences– Genetics and Plant Breeding

Aim of the course

To impart theoretical knowledge and practical skills about plant breeding objectives, genetic consequences, breeding methods for crop improvement.

Theory

Unit I

Early Plant Breeding; Accomplishments through plant breeding; Objectives of plant breeding; Patterns of Evolution in Crop Plants: Centre of Origin, Agro-biodiversity and its significance. Pre-breeding and plant introduction and role of plant genetic resources in plant breeding.

Unit II

Genetic basis of breeding: self and cross pollinated crops including mating systems and response to selection; Nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding.

Unit III

Pure line theory, pure line and mass selection methods; pedigree, bulk, backcross, single seed descent and multiline breeding; Population breeding in self-pollinated crops with special reference to diallel selective mating; Transgressive breeding.

Unit IV

Breeding methods in cross pollinated crops; Population breeding: mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny

selection schemes, recurrent selection schemes for intra and inter-population improvement and development of synthetics and composites. Hybrid breeding: genetical and physiological basis of heterosis and inbreeding, production of inbreeds, breeding approaches for improvement of inbreeds, predicting hybrid performance; seed production of hybrid and their parent varieties/ inbreeds. Self-incompatibility, male sterility and apomixes in crop plants and their commercial exploitation.

Unit V

Breeding methods in asexually/ clonally propagated crops, clonal selection.

Unit VI

Special breeding techniques: Mutation breeding, Breeding for abiotic and biotic stresses; Concept of plant ideotype and its role in crop improvement, concept of MAS, concept of polyploidy and wide hybridization, doubled haploidy.

Unit VII

Cultivar development: testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Practical

• Floral biology in self and cross pollinated species;

• Selfing and crossing techniques;

• Selection methods in segregating populations and evaluation of breeding material;

• Analysis of variance (ANOVA);

• Estimation of heritability and genetic advance;

• Maintenance of experimental records;

• Learning techniques in hybrid seed production using male-sterility in field crops;

• Prediction of performance of double cross hybrid.

Teaching methods

• Power point presentation

• Chalk and Board

• Smart board

• Lectures

• Assignments, quiz

• Group tasks, student's presentations

Learning outcome

The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling. The course will also acquaint the student with importance of floral biology, mutation breeding and participatory plant breeding, etc.

Suggested Reading

Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons. Chahal GS and Gossal, SS. 2002. Principles and Procedures of Plant Breeding Biotechnological and Conventional approaches. Narosa Publishing House. Chopra VL. 2004. Plant Breeding. Oxford & IBH. George A. 2012. Principles of Plant Genetics and Breeding. John Wiley & Sons. Gupta SK. 2005. Practical Plant Breeding. Agribios. Jain HK and Kharakwal MC. 2004. Plant Breeding and–Mendelian to Molecular Approach, Narosa Publications, New Delhi Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill. Sharma JP. 2010. Principles of Vegetable Breeding. Kalyani Publ, New Delhi. Simmonds NW.1990. Principles of Crop Improvement. English Language Book Society. Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi. Singh S and Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.

Course Title : Fundamentals of Quantitative Genetics*

Course Code : GPB 503

Credit Hours : 3 (2+1)

Course Title : Molecular Breeding and Bioinformatics*

Course Code : GPB 506

Credit Hours : 3(2+1)

Why this course?

The course will provide deep knowledge to the students on genotyping and kinds of markers including biochemical and molecular, mapping populations, allele mining. This will also add ways to perform marker-assisted selection and gene pyramiding to evolve superior varieties.

Aim of the course To impart knowledge and practical skills to use innovative approaches and Bioinformatics in Plant Breeding.

Theory

Unit I

Genotyping; Biochemical and Molecular markers; Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs, etc.), Functional markers; Mapping populations (F2s, back crosses, RILs, NILs and DH); Molecular mapping and tagging of agronomically important traits; Statistical tools in marker analysis.

Unit II

Allele mining; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants; Marker-assisted backcross breeding for rapid introgression; Genomics- assisted breeding; Generation of EDVs; Gene pyramiding.

Unit III

Introduction to Comparative Genomics; Large scale genome sequencing strategies; Human genome project; Arabidopsis genome project; Rice genome project; Comparative genomics tools; Introduction to proteomics; 2D gel electrophoresis; chromatography and sequencing by Edman degradation and mass spectrometry; Endopeptidases; Nanotechnology and its applications in crop improvement.

Unit IV

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer; Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane, etc. and commercial releases; Biotechnology applications in male sterility/ hybrid breeding, molecular farming; Application of Tissue culture in molecular breeding; MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights; Introduction to bioinformatics: bioinformatics tools, biological data bases (primary and secondary), implications in crop improvement.

Practical

• Requirements for plant tissue culture laboratory;

• Techniques in plant tissue culture;

• Media components and media preparation;

• Aseptic manipulation of various explants, observations on the contaminants occurring in media, interpretations;

• Inoculation of explants, callus induction and plant regeneration; Standardizing the protocols for regeneration;

• Hardening of regenerated plants; Establishing a greenhouse and hardening procedures; Plant Sciences

• Visit to commercial micropropagation unit;

• Transformation using Agrobacterium strains;

• GUS assay in transformed cells/ tissues;

• DNA isolation, DNA purity and quantification tests;

• Gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship;

• Construction of genetic linkage maps using computer software;

• NCBI Genomic Resources, GBFF, Swiss Prot, Blast n/ Blast p, Gene Prediction Tool, Expasy Resources, PUBMED and PMC, OMIM and OMIA, ORF finder;

• Comparative Genomic Resources: - Map Viewer (UCSC Browser and Ensembl);

• Primer designing- Primer 3/ Primer BLAST.

Teaching methods

• Power point presentation

• Chalk and Board

• Smart board

• Lectures

• Assignments, quiz

• Group tasks, student's presentations

Learning Outcome The knowledge of this course will enable the student to know about various molecular tools and approaches for genotyping and marker assisted breeding, intellectual property rights, bioinformatics tools and their uses in crop improvement.

Suggested Reading

Azuaje F and Dopazo J. 2005. Data Analysis and Visualization in Genomics and Proteomics. John Wiley and Sons. Brown TA. 1991. Essential Molecular Biology: a practical Approach. Oxford university press, 2002, 2nd edition Chawala HS. 2000. Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. Chopra VL and Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methods and Applications. Oxford & IBH. Gupta PK. 1997. Elements of Biotechnology. Rastogi Publ. Hackett PB, Fuchs JA and Messing JW. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co. Jollès P and Jörnvall H. 2000. Proteomics in Functional Genomics: Protein Structure Analysis. Birkhäuser. Lewin B. 2017. Genes XII. Jones & Bartlett learning, 2017. Robert NT and Dennis JG. 2010. Plant Tissue Culture, Development,

This course will make the student well versed with the process of mutation and its use in crop improvement. This course will also give in depth knowledge of mutations in genomics, allele mining and TILLING.

Suggested Reading

Alper T. 1979. Cellular Radiobiology. Cambridge Univ. Press, London. Chadwick KH and Leenhouts HP. 1981. The Molecular Theory of Radiation Biology. SpringerVerlag. Cotton R, Edkin E and Forrest S. 2000. Mutation Detection: A Practical Approach. Oxford Univ. Press. International Atomic Energy Agency. 1970. Manual on Mutation Breeding. International Atomic Energey Agency, Vienna, Italy. Shu QY, Forster BP and Nakagawa N. 2012. Plant Mutation Breeding and Biotechnology. Gutecnberg Press Ltd. Rome Italy ISBN:978-925107-022-2 (FAO). Singh BD. 2003. Genetics. Kalyani Publishers, New Delhi. Strickberger MW. 2005. Genetics. 3rd Ed. Prentice Hall. www.barc.gov.in

Course Title : Breeding for Stress Resistance and Climate Change

Course Code : GPB 516

Credit Hours : 3(2+1)

Why this course?

Climate change is a big challenge to sustain higher crop productivity and nutritional quality. Concept of breeding for stress tolerance and development of hybrids/ varieties for climate change is of prime importance in plant breeding. Therefore this course is essential for budding plant breeders.

Aim of the course

To apprise about various abiotic and biotic stresses influencing crop yield, mechanisms and genetics of resistance and methods to breed stress tolerant varieties.

Theory

Unit I

Concept and impact of climatic change; Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops.

Unit II

Concepts of resistance to insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defence mechanisms against viruses and bacteria.

Unit III

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants; Quantitative resistance/ adult plant resistance and slow rusting resistance; Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies; Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications. Classification of abiotic stresses - Stress inducing factors, moisture stress/ drought and water logging and submergence; Acidity, salinity/ alkalinity/ sodicity; High/ low temperature, wind, etc.; Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

Unit IV

Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence, high and low/ freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton, etc.; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/ contaminants in soil, water and environment.

Unit V

Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops; Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitinases and Bt for diseases and insect pest management.

Practical

• Understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them for diseases caused by fungi and bacteria;

• Symptoms and data recording; use of MAS procedures;

• Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level;

• Phenotypic screening techniques for nematodes and borers; Ways of combating them;

• Evaluating the available populations like RIL, NIL, etc. for pest resistance;

• Use of standard MAS procedures. Breeding strategies - Weeds – ecological, environmental impacts on the crops;

• Breeding for herbicide resistance;

• Screening crops for drought and flood resistance; factors to be considered and breeding strategies;

• Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies;

• Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation.

Teaching methods

• Power point presentation

• Chalk and Board

• Smart board

• Lectures

• Assignments, quiz

• Group tasks, student's presentations

Learning outcome

After completion of this course the student will be able to well verse with the stress and its causes. This will enable the students for the development of RIL, NIL, etc. for pest resistance and Use of standard MAS procedures

Suggested Reading

Blum A. 1988. Plant Breeding for Stress Environments. CRC Press. Christiansen MN and Lewis CF. 1982. Breeding Plants for Less Favourable Environments. Wiley International. Fritz RS and Simms EL. (Eds.). 1992. Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics. The University of Chicago Press. Li PH and Sakai A. 1987. Plant Cold Hardiness. Liss, New York Springer Luginpill P. 1969. Developing Resistant Plants - The Ideal Method of Controlling Insects. USDA, ARS, Washington DC. Maxwell FG and Jennings PR. (Eds.). 1980. Breeding Plants Resistant to Insects. John Wiley & Sons. Wiley-Blackwell. Roberto F. 2018. Plant Breeding for Biotic and Abiotic Stress Tolerance. Springer. Russel GE. 1978. Plant Breeding for Pest and Disease Resistance. Butterworths. Sakai A and Larcher W. 1987. Frost Survival in Plants. Springer-Verlag. Plant Sciences–Genetics and Plant Breeding 39 Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi. Turener NC and Kramer PJ. 1980. Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons. van der Plank JE. 1982. Host-Pathogen Interactions in Plant Disease. Academic Press.

Note: For minor courses please refer the concerned department's courses outline

Burges HD and Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London. De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman and Hall, New York. Dhaliwal GS and Arora R. 2001. Integrated Pest Management: Concepts and Approaches. Kalyani Publishers, New Delhi. Gerson H and Smiley RL. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman and Hall, New York. Huffaker CB and Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London. Ignacimuthu SS and Jayaraj S. 2003. Biological Control of Insect Pests. Phoenix Publ., New Delhi. Saxena AB. 2003. Biological Control of Insect Pests. Anmol Publ., New Delhi. Van Driesche and Bellows TS. Jr. 1996. Biological Control. Chapman and Hall, New York.

Course Title : Toxicology of Insecticides

Course Code : ENT 506

Credit Hours : 3 (2+1)

Aim of the course

To orient the students with structure and mode of action of important insecticidesbelonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Theory

Unit I

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

Unit II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature; categorization of insecticides on the basis of toxicity – criteria for bees, beneficial insects and other insects in general; structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds/ new insecticide molecules; nanopesticides; drawbacks of insecticide abuse.

Unit III

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticidessynergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity. bioassay definition, objectives, criteria, factors, problems and solutions.

Unit IV

Insecticide metabolism; insect-pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

Unit V

Insecticide residues, their significance and environmental implications; procedures of insecticide residue analysis. Insecticide Act, registration procedures, label claim, and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

Practical

- Insecticide formulations and mixtures;
- Laboratory and field evaluation of bio-efficacy of insecticides;
- Bioassay techniques;
- Probit analysis;
- Evaluation of insecticide toxicity;
- Toxicity to beneficial insects;
- Pesticide appliances;
- Working out doses and concentrations of pesticides;
- Procedures of residue analysis.

Learning outcome

- Students are expected understand the concept of toxicity, bio-efficacy, insecticide formulations, modes of action of insecticides, estimation of insecticide residues and have significant know-how about the functioning of various types of spray equipments.

Suggested Reading

Chattopadhyay SB. 1985. Principles and Procedures of Plant Protection. Oxford and IBH, New Delhi.Dodia DA, Petel IS and Petal GM. 2008. Botanical Pesticides for Pest Management. Scientific Publisher (India), Jodhpur. Dovener RA, Mueninghoff JC and Volgar GC. 2002. Pesticides formulation and delivery systems: meeting the challenges of the current crop protection industry. ASTM, USA Gupta HCL.1999. Insecticides: Toxicology and Uses. Agrotech Publ., Udaipur. Ishaaya I and Degheele (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi.

Ishaaya I and Degheele D. 1998. Insecticides with Novel Modes of Action: Mechanism and Application. Norosa Publishing House, New Delhi. Krieger RI. 2001. Handbook of Pesticide Toxicology. Vol-II. Academic Press. Orlando Florida. Mathews GA. 2002. Pesticide Application Methods. 4th Ed. Intercept. UK. Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York. Otto D and Weber B. 1991. Insecticides: Mechanism of Action and Resistance. Intercept Ltd., UK. Pedigo LP and Marlin ER. 2009. Entomology and Pest Management, 6th Edition, Pearson Education Inc., Upper Saddle River, New Jersey 07458, U.S.A. Perry AS, Yamamoto I, Ishaaya I and Perry R. 1998. Insecticides in Agriculture and Environment. Narosa Publ. House, New Delhi. Prakash A and Rao J. 1997. Botanical Pesticides in Agriculture. Lewis Publication, New York. Roy NK. 2006. Chemistry of Pesticides. Asia Printograph Shahdara Delhi.

Course Title : Concepts of Integrated Pest Management

Course Code : ENT 508

Credit Hours : 2 (2+0)

Aim of the course

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL and implementing IPM programmes.

Theory

Unit I

History, origin, definition and evolution of various terminologies. Importance of resistance, principles, classification, components, types and mechanisms of resistance. National and international level crop protection organizations; insecticide regulatory bodies; synthetic insecticide, bio-pesticide and pheromone registration procedures; label claim of pesticides – the pros and cons.

Unit II

Concept and philosophy, ecological principles, economic threshold concept and economic consideration. Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

Unit III

Tools of pest management and their integration- legislative, quarantine regulations, cultural, physical and mechanical methods; semiochemicals, biotechnological and bio-rational approaches in IPM. Pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; costbenefit ratios and partial budgeting; case studies of successful IPM programmes. ITK-s in IPM, area-wide IPM and IPM for organic farming; components of ecological engineering with successful examples.

Unit IV

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses; global and Indian scenario of crop losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system. Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

Learning outcome

• Students are expected to have significant knowledge of IPM concepts, estimation of losses due to insect pests, computation of ETL, EIL and should be able take management decisions.

Suggested Reading

Dhaliwal GS and Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publishers, New Delhi. Horowitz AR and Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi. Ignacimuthu SS and Jayaraj S. 2007. Biotechnology and Insect Pest Management. Elite Publ., New Delhi. Norris RF, Caswell-Chen EP and Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi. Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi. Subramanyam B and Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York.

Course Title : Pests of Field Crops

Course Code : ENT 509

Credit Hours : 3 (2+1)

Aim of the course

AGRICULTURAL EXTENSION EDUCATION

Course Title : Extension Landscape

Course Code : EXT 501

Credit Hours : 2+0

Why this course?

Extension and advisory services (EAS) need to support farmers to deal with several new challenges they face currently. To effectively support farmers, EAS should perform several new functions and it should have capacities to perform these functions. EAS have evolved considerably especially during the last 3 decades. Several new approaches have emerged and many new funding and delivery models emerged in response to reforms (economic policies and new governance structure) implemented in several countries. Apart from these, new insights from communication and innovation studies have also started to influence the practice of extension. There is a lot of interest globally in strengthening pluralistic EAS and enhancing its contribution towards development of an effective Agricultural Innovation System (AIS). Keeping these in view, there is a need to orient students of extension on how extension is shaped globally and the policy level challenges it faces so that the extension students fit well to the global demand for competent extension professionals who can appreciate and understand this changing context.

Aim of the course

The aim of this course is to introduce the new challenges before extension and how extension is evolving globally. It presents the new capacities that are needed by EAS providers to provide a much wider support to farmers and it orient students to the new insights from communication and innovation studies that are influencing the practice of extension globally. The course also help students to appreciate the process and the impact of extension reforms implemented in many countries, the new approaches that are evolving globally in different regions and the policy challenges in managing a pluralistic extension system. The course is organized as follows:

No	Blocks	Units
1	Globally,What is new in Extension?	1. Challenges Before Extension and Advisory Services

	2. New Functions and New Capacities
	3. Pluralism in EAS
2. Insights from Communication & Innovation Studies & New	1. From the Linear Paradigm To Systems Paradigm
Extension Approaches	2.Evolving Extension Approaches
3 Extension Reforms And Policy Challenges	1.Changes In Governance, Funding and Delivery of EAS
	2. Challenges In Managing Pluralistic EA

Learning outcome

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

– Appreciate the changing global extension landscape

– Broaden their understanding on the role of EAS in agricultural innovation system

– Critically evaluate the reforms in extension and the evolving approaches in extension

– Analyse the policy level challenges in extension funding and delivery

Block 1: Globally, What Is New In Extension?

Unit 1:Challenges before Extension and Advisory Services (EAS)

Extension and Advisory Services (EAS)- Meaning (embracing pluralism and new functions) New Challenges before farmers and extension professionals: Natural Resource Management-Supporting farmers to manage the declining/deteriorating water and soil for farming; Gender Mainstreaming-How extension can enhance access to new knowledge among women farmers; Nutrition- Role of extension in supporting communities with growing nutritious crop and eating healthy food; Linking farmers to markets- Value chain extension including organizing farmers, strengthen value chain and supporting farmers to respond to new standards and regulations in agri-food systems; Adaptation to climate changes-How extension can contribute to up-

scaling Climate Smart Agriculture; Supporting family farmsstrengthening the capacities of family farms; Migration-Advising farmers to better respond to opportunities that emerge from increasing mobility and also supporting migrants in enhancing their knowledge and skills; Attracting and Retaining Youth in Agriculture including promotion of agripreneurship and agri-tourism; Urban and peri-urban farming- How to support and address issues associated with urban and peri-urban agriculture; Farmer distress, suicides- Supporting farmers in tackling farm distress.

Unit 2: New Functions and New Capacities

Beyond transfer of technology: Performing new functions to deal with new challenges; Organising producers into groups-dealing with problems that need collective decision making such as Natural Resource Management (NRM) and access to markets; Mediating conflicts and building consensus to strengthen collective decision making; Facilitating access to credit, inputs and services-including development of service providers; Influencing policies to promote new knowledge at a scale Networking and partnership development including convening multi-stakeholder platforms/ innovation platforms.

New Capacities needed by extension and advisory services at different levels –at the individual (lower, middle management and senior management levels), organizational and enabling environment levels; –Core competencies at the individual level; Varied mechanisms for capacity development (beyond training).

Unit 3:

Pluralism in EAS Pluralism in Extension Delivery: Role of private sector (input firms, agri-business companies, consultant firms and individual consultants)- Trends in the development of private extension and advisory services in India and other countries; challenges faced by private extension providers; Role of Non-Governmental Organizations (National/international)/ Civil Society Organizations (CSOs) in providing extensionExperiences from India and other countries; Producer Organizations- Role in strengthening demand and supply of extension services; their strength andweaknesses-experiences from different sectors; Role of Media and ICT advisory service providers; global experiences with use of media and ICTs in advisory services provision.

Block 2:Insights From Innovation Studies and New Extension Approaches

Unit 1:From the Linear Paradigm to Systems Paradigm

Diffusion of Innovations paradigm- strengths and limitations; multiple sources of innovation-farmer innovation, institutional innovation; farmer participation in technology generation and promotion; strength and limitations; Agricultural Knowledge and Information Systems (AKIS); strength and limitations; Agricultural Innovation Systems (AIS); Redefining Innovation- Role of Extension and Advisory Services in AIS-From information delivery to intermediation across multiple nodes; Role of brokering; Innovation Platforms, Innovation Management; Strength and weaknesses of AIS. Rethinking Communication in the Innovation Process – Network building, support social learning, dealing with dynamics of power and conflict.

Unit 2:Evolving Extension Approaches

Evolution and features of extension approaches: Transfer of technology approach; educational approach, farmer participatory extension approach, demand-driven extension, market led extension (value chain extension), extension for climate smart agriculture, gender sensitive extension, extension for entrepreneurship Extension systems in different regions: Asia-Pacific, Europe, Latin America, Australia, North America Networking for Strengthening EAS: GFRAS (Global Forum for Rural Advisory Services) and its regional networks.

Block 3: Extension Reforms and Policy Challenges

Unit 1: Changes in Governance, Funding and Delivery

Reduction in public funding: public withdrawal from extension provision (partial/ full); Examples/Cases; Privatization: Public funding and private delivery; cost sharing and cost recovery; Examples/Cases; Decentralisation of extension services; Examples/ Cases; Lessons from extension reforms in different countries; Extension and Sustainable Development Goals (SDGs).

Unit 2:Challenges in Managing Pluralistic Extension Systems

Pluralism: Managing pluralism and Co-ordination of pluralistic extension provision; Public private partnerships in extension (including the role of local governments/ panchayats and producer organisations); Examples, challenges in co-ordination; Achieving convergence in extension planning and delivery,

Financing Extension: Mobilising resources for extension: public investments, donor support (grants/loans); Monitoring and Evaluation of Extension: Generating appropriate data for Assessment and Evaluation of pluralistic extension; Strengthening extension policy interface; generating evidence on impact of extension and policy relevant communication.

Teaching methods/activities

– Lecture

– Assignment (Reading/Writing)

– Book Review by students

– Student presentation

– Group Work

Suggested Reading

Adolph B. 2011. Rural Advisory Services World wide: A Synthesis of Actors and Issues. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/knowledge/gfras-publications.html? download=6: rural-advisory-services-worldwide&start=40

Ashok G, Sharma P, Anisha S and Prerna T. 2018. Agriculture Extension System in India Review of Current Status, Trends and the Way Forward. Indian Council for Research on International Economic Relations (ICRIER). http://icrier.org/pdf/Agriculture-ExtensionSystem-in-India-2018.pdf Barber J, Mangnus E and Bitzer V. 2016. Harnessing ICT for agricultural extension. KIT Working Paper 2016: 4. https://213ou636sh0ptphd141fqei1-wpengine.netdna-ssl.com/sed/wp-content/ uploads/sites/2/2016/11/KIT_WP2016- 4_Harnessing-ICT-for-agricultural-extension.pdf

Bentley J, Chowdhury A and David S. 2015. Videos for Agricultural Extension. Note 6. GFRAS Good Practice Notes for Extension and Advisory Services. GFRAS: Lindau, Switzerland. https://www.g-fras.org/en/good-practice-notes/6-video-for-agricultural-extension.html #SNote1

Bingen RJ and Simpson BM. 2015. Farmer Organizations and Modernizing Extension and Advisory Services. MEAS Discussion Paper.

Gilovich T, Keltner D, and Nisbett RE. 2011. Social psychology. New York: W.W. Norton & Co. Moreno R. 2010. Educational Psychology. Hoboken, NJ: John Wiley & Sons Inc. Nevid JS. 2012. Essentials of psychology: Concepts and applications Belmont, CA: Wadsworth, Cengage Learning. Rachlin H. 1989. Judgment, decision, and choice: A cognitive/behavioral synthesis. New York: W.H. Freeman.

Course Title :Organisational Behavior and Development

Course Code : EXT 503

Credit Hours : 2+1

Why this course?

In changing and competitive world, the survival of any organization is dependent on its ability to adjust to the new challenges, adapt its structure and develop the competencies needed among its staff. This course is designed to understand the theory and practice relating to the processes of organizational behavior, development and change. It attempts to bring about change in the different levels of the organization (the individual, group and organization) using a wide variety of interventions.

Aim of the course

• To understand the theory and practice relating to the processes of organizational behavior, development and change.

• To develop insight and competence in diagnostic and intervention processes andskills for initiating and facilitating change in organizations.

• To gain necessary self-insight, skills in facilitation, organizational development (OD) skills, group process and techniques, to become an effective change agents and OD consultants.

• To understand the behavior of individuals and small groups in organization with special focus on beliefs, attitudes and values, human inference - attribution, selfconcept, motivation, active listening, interpersonal communication, conflicts management.

The course is organized as follows:

No Blocks Units

1. OrganisationalBehaviour	1. Basics of Organisation
	2. Basics of OrganisationalBehaviour
	3. Individual Behaviour in Organizations
	4. Group Behaviour in Organizations
	5.Productive Behaviour and Occupational Stress
	6. Organisational Systems
2. Organisational Development	1.Overview of Organisational Development
	2.Managing the Organisational Development Process
	3. Organisational Development Interventions
	4. Organisational Development Practitioner or Consultant

Theory

Block 1: Organizational Behavior

Unit 1: Basics of Organization

Introduction to organizations-concept and characteristics of organizations; Typology of organizations; Theories of organizations: nature of organizational theory, Classical theories, Modern management theories, System Theory - Criticisms and lessons learnt/ analysis.

Unit 2: Basics of Organizational Behaviour

Concepts of OrganisationalBehaviour, Scope, Importance, Models of OB.

Unit 3: Individual Behaviour in Organizations

Introduction, Self-awareness, Perception and Attribution, Learning, Systems approach to studying organization needs and motives – attitude, values and ethical behavior, Personality, Motivation-Concept & Theories, Managing motivation in organizations.

Unit 4: Group Behaviour in Organization

Foundations of group, group behaviour and group dynamics, Group Development and Cohesiveness, Group Performance and Decision Making, Intergroup Relations; Teams in Organizations-Team building experiential exercises, Interpersonal Communication and Group; Leadership: Meaning, types, Theories and Perspectives on Effective Leadership, Power and Influence, managing Conflict and Negotiation skills, Job/ stress management, decision-making, problem-solving techniques.

Unit 5: Productive Behaviour and Occupational Stress

Productive behaviour - Meaning, dimension; Job analysis and Job performance – meaning, dimensions, determinants and measurement; Job satisfaction and organizational commitment - meaning, dimensions and measures roles and role clarity; Occupational stress – meaning, sources, theories and models, effects, coping mechanism, effects and management; Occupational stress in farming, farmer groups/ organizations, research and extension organizations.

Unit 6: Organizational System

Organizations Structure- Need and Types, Line & staff, functional, committee, project structure organizations, centralization &decentralization, Different stages of growth and designing the organizational structure; Organizational DesignParameters of Organizational Design, Organization and Environment, Organizational Strategy, Organization and Technology, Power and Conflicts in Organizations, Organizational Decision-Making; Organizational Culture vs Climate; Organizational Change; Organizational Learning and Transformation.

Block 2: Organisational Development

Unit 1: Overview of Organizational

Development Concept of OD, Importance and Characteristics, Objectives of OD, History and Evolution of OD, Implications of OD Values.

Unit 2: Managing the Organizational Development

Process Basic Component of OD Program-Diagnosis-contracting and diagnosing the problem, Diagnostic models, open systems, individual level group level and organizational level diagnosis; Action-collection and analysis for diagnostic information, feeding back the diagnosed information and interventions; Program Management- entering OD relationship, contracting, diagnosis, feedback, planned change, intervention, evaluation.

Unit 3: Organizational Development Interventions

Meaning, Importance, Characteristics of Organization development Interventions, Classification of OD Interventions-Interpersonal interventions, Team Interventions, Structural Interventions, Comprehensive Interventions.

Unit 4: Organizational Development Practitioner or Consultant

Who is OD consultant? Types of OD consultants and their advantages, qualifications, Comparison of traditional consultants Vs. OD consultants, Organizational Development process by the practitioners skills and activities.

Practicals

• Case Analysis of organization in terms of process – attitudes and values, motivation, leadership.

• Simulation exercises on problem-solving – study of organizational climate in different organizations.

• Study of organizational structure of development departments, study of departmentalization, span of control, delegation of authority, decision-making patterns.

• Study of individual and group behaviour at work in an organization.

• Conflicts and their management in an organization.

Comparative study of functional and nonfunctional organizations and drawing factors for organizational effectiveness.

• Exercise on OD interventions (Interpersonal, Team, Structural, Comprehensive) with its procedure to conduct in an organization

VIII. Teaching methods/activities

– Lecture cum discussion

– Cases

– Class exercises

– Group Presentation

Learning outcome

This course will equip the students to become potential change agents and OD practitioners. They should be able to learn how to improve individual, group/team and organizational performance through the use of OD techniques or interventions.

Suggested Reading

Bhattacharyya DK. 2011. Organizational Change and Development, Oxford University Press. Hellriegel D, Sloccum JW and Woodman. 2001. Organizational Behaviour. Cincinnati, Ohio: South-Western College Pub. Luthans F. 2002. Organizational Behaviour. Tata McGraw-Hill, New York Newstrom JW and Davis K. 2002. Organizational Behaviour: Human behaviour at Work. TataMcGraw Hill, New Delhi. Peter MS. 1998. The Fifth Discipline: The Art and Practice of Learning Organization. Random House, London. Pradip NK. 1992. Organizational Designs for Excellence. Tata McGraw Hill, New Delhi. Shukla, Madhukar. 1996. Understanding Organizations. Prentice Hall of India, New Delhi. Stephens PR and Timothy AJ. 2006. Organizational Behaviour, 12th Edition. Prentice Hall Pub. Thomas GC and Christopher GW. 2013. Organizational development and change, 10th edition, South-Western college publishing. Wendell LF and Cecil HB. 1999. Organizational Development: Behavioural science interventions for organization improvement, Pearson. 368 pp.

Course Title : Research Methodology in Extension

Course Code : EXT 504

Credit Hours : 2+1

Why this course?

Growth of any discipline is directly proportional to the creation of knowledge in that discipline. Extension research is the backbone of extension discipline. Extension research is a unique social science inquiry where research ideas are gathered from the field problems and put through a systematic cycle of objective investigations that result in significant solutions. Apart from developing theories and models that advance scientific knowledge, extension research should also provide new insights for improving extension policy and practice. As extension is a field oriented discipline seeking to improve the welfare of its stakeholders, the extension professionals require critical

publications.html? download=414: social-mediashaping-the-future-of-agricultural-extension-and-advisory-services Vignare K. 2013. Options and strategies for information and communication technologies within agricultural extension and advisory services. MEAS Discussion paper. http://meas.illinois.edu/wpcontent/uploads/2015/04/Vignare-K-2013-ICT-and-ExtensionMEAS-Discussion-Paper.pdf World Bank. 2017. ICT in Agriculture (Updated Edition): Connecting Smallholders to Knowledge, Networks, and Institutions. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/27526 Websites FAO–Food and Agricultural Organisation (Research and Extension) http://www.fao.org/research-and-extension/en/ CTA–The Technical Centre for Agricultural and Rural Cooperation: Digitalization–https://www.cta.int/en/channel/digitalisation-sid05951b8c7-e611-4f34-9ae6-8c0fc0c822bc GFRAS–Global Forum for Rural Advisory Services–http://www.g-fras.org/en/ AESA–Agricultural Extension in South Asia–http://www.aesanetwork.org/

Course Title : Evaluation and Impact Assessment

Course Code : EXT 507

Credit Hours : 2+1

Why this course?

Many organizations now look for experts to evaluate development projects and developmental interventions. It is now required that impact be assessed whenever any development programme is implemented. Thus, the extension professionals need to have good understanding of the theory and practice of programme evaluation and impact assessment. This course, thus, has been designed to help students develop as extension professionals who can plan and conduct systematic assessments of the results and impacts of extension programmes.

Aim of the course

- To orient students on the importance of evaluation and impact assessment
- To develop capacities for evaluation and impact assessment
- Discuss ways of conducting evaluations and impact assessment

The course is organized as follows:

No Blocks	Units
1. Programme Evaluation	1. Introduction to Evaluation
	2. Evaluation Theories
2. Evaluation Process	1. How to Conduct Evaluation
	2. Evaluating the Evaluation
3. Programme Management Techniques	1. SWOT Analysis and Bar Charts
	2. Networks
4. Programme Evaluation Tools	1. Bennett's Hierarchy of Evaluation
	2. Logic Framework Approach
5. Impact Assessment	1. Introduction to Impact Assessment
	2. Impact Assessment Indicators
	3. Approaches to Impact Assessment

Theory

Block 1: Programme Evaluation

Unit 1: Introduction to Evaluation

Concept of Evaluation: Meaning and concept in different contexts; Why Evaluation is Done and When? Programme planning, analyseprogramme effectiveness, decision making, accountability, impact assessment, policy advocacy; Objectives, types, criteria and approaches of programme evaluation, evaluation principles; the context of program evaluation in agricultural extension; Role and Credibility of Evaluator: Role as educator, facilitator, consultant, interpreter, mediator and change agent. Competency and credibility of evaluator.

Unit 2: Evaluation Theories

Evaluation theory vs. practice – synergistic role between practice and theory in evaluation; Evaluation theories - Three broad categories of theories that evaluators use in their works - programme theory, social science theory, and evaluation theory (other theories/ approaches - Utilization-Focused Evaluation

& Utilization-Focused Evaluation (U-FE) Checklist, Values Engaged Evaluation, Empowerment Evaluation, Theory-Driven Evaluation). Integration between theory and practice of evaluation: –evaluation forums, workshops, conferences and apprenticeship/ internship.

Block 2: Evaluation Process

Unit 1: How to Conduct Evaluation

Ten Steps in programme evaluation: (1) Identify and describe programme you want to evaluate (2) Identify the phase of the programme(design, start-up, ongoing, wrap-up, follow-up) and type of evaluation study needed (needs assessment, baseline, formative, summative, follow-up) (3) Assess the feasibility of implementing an evaluation (4) Identify and consult key stakeholders (5) Identify approaches to data collection (quantitative, qualitative, mixed) (6) Select data collection techniques (survey interviews and questionnaires with different types) (7) Identify population and select sample (sampling for evaluation, sample size, errors, sampling techniques (8) Collect, analyse and interpret data (qualitative and quantitative evaluation data analysis) (9) Communicate findings (reporting plan, evaluation report types, reporting results, reporting tips, reporting negative findings (10) Apply and use findings (programme continuation/ discontinuation, improve on-going programme, plan future programmes and inform programme stakeholders).

Unit 2: Evaluating the Evaluation

Evaluating the Evaluation - 10 Steps as above with focus on conceptual clarity,representation of programme components and stakeholders, sensitivity, representativeness of needs, sample and data, technical adequacy, methods used for data collection and analysis, costs, recommendations and reports.

Block 3: Programme Management Techniques

Unit 1: SWOT Analysis and Bar Charts

SWOT Analysis – Concept, origin and evolution; SWOT As a Programme Management Tool; Conducting SWOT Analysis - Common Questions in SWOT Analysis; Advantages and Disadvantages of SWOT; Bar Charts (Gantt Charts and Milestone Charts) - Characteristics, advantages and limitations.

Unit 2: Networks

Networks – Introduction, origin and widely used networks (Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM),

differences between PERT and CPM, advantages and disadvantages. Networks Terminology – Activity, Dummy activity, Event (predecessor event, successor event, burst event, merge event, critical event), Earliest Start Time (EST), Latest Start Time (LST), Critical Path, Critical Activity, Optimistic time (To), Pessimistic time (Po), Most likely time (TM), Expected time (TE), Float or Slack, Event Slack, Lead time, Lag time, Fast tracking, Crashing critical path, Acclivity Table, Danglers, Normal Time. Rules for Preparation of Networks and Steps in Network Preparation with example.

Block 4: Programme Evaluation Tools

Unit 1: Bennett's Hierarchy of Evaluation

Introduction to Bennett's hierarchy – Background and description; Relation between programme objectives & outcomes at 7 levels of Bennett's hierarchy – Inputs, activities, participation, reactions, KASA changes, practice and behaviour changes, end results. Advantages and Disadvantages of Bennett's hierarchy

Unit 2: Logic Framework Approach (LFA)

Introduction to LFA – Background and description; Variations of LFA - Goal Oriented Project Planning (GOPP) or Objectives Oriented Project Planning (OOPP); LFA Four-by-Four Grid – Rows from bottom to top (Activities, Outputs, Purpose and Goal & Columns representing types of information about the events (Narrative description, Objectively Verifiable Indicators (OVIs) of these events taking place, Means of Verification (MoV) where information will be available on the OVIs, and Assumptions). Advantages and Disadvantages of LFA.

Block 5: Impact Assessment

Unit 1: Introduction to Impact Assessment

Concept of Impact Assessment: Meaning, concept and purpose in different contexts; Impact Assessment Framework: Meaning of inputs, outputs, outcomes, impacts and their relation with monitoring, evaluation and impact assessment.

Unit 2: Impact Assessment Indicators

Indicators for impact assessment – meaning and concept; Selecting impact indicators; Types of impact indicators for technology and extension advisory services - social and behavioral indicators, socio-cultural indicators, technology level indicators, environmental impact assessment indicators and institutional impact assessment indicators.

Unit 3: Approaches for Impact Assessment

Impact assessment approaches – Quantitative, qualitative, participatory and mixed methods with their advantages and disadvantages; Quantitative Impact Assessment Types – Based on Time of Assessment (Ex-ante and ex-post), Based on Research Design (Experimental, quasi experimental, Non-experimental). Econometric Impact Assessment: - (Partial Budgeting Technique, Net Present Value, Benefit Cost Ratio, Internal Rate of Return, Adoption Quotient, etc). Qualitative and Participatory Impact Assessment Methods.

Unit 4: Environment Impact Assessment (EIA)

Concept of EIA – Introduction, What it is? Who does it? Why it is conducted? How it is done?; Benefits and important aspects of EIA-risk assessment, environmental management and post product monitoring. Environmental Components of EIA – air, noise, water, biological, land; Composition of the expert committees and Steps in EIA process - screening, scoping, collection of baseline data, impact prediction, mitigation measures and EIA report, public hearing, decision making, monitoring and implementation of environmental management plan, assessment of alternatives, delineation of mitigation measures and EIA report; Salient Features of 2006 Amendment to EIA Notification - Environmental Clearance/Rejection, participants of EIA; Shortcomings of EIA and How to improve EIA process?

Practicals

• Search the literature using web / printed resources and identify evaluation indicators for the following:

– Utilization-Focused Evaluation

– Values Engaged Evaluation

– Empowerment Evaluation

– Theory-Driven Evaluation

• Visit Directorate of Extension in your university and enquire about extension programmes being implemented / coordinated by Directorate. Develop an evaluation proposal of any one programme using 'Ten Steps in Programme Evaluation' discussed in the theory class.

• Review any comprehensive programme evaluation report from published sources. Evaluate the report and write your observations following the 'Evaluating the Evaluation' approach.

• Identify at least four agriculture development programmes and their objectives being implemented in your state. Write two attributes each on Strengths, Weaknesses, Opportunities and Threats related to the identified programme objectives in the SWOT grid.

• Identify an on-going development programme and make-out 6 activities from the programme. • Draw a Gantt chart for 12 months programme activities.

• Write a report on evaluation hierarchy levels and indicators as per Bennett's hierarchy of evaluation for any development programme or project.

• Develop LFA four-by-four grid for any development programme or project with activities, outputs, purpose and goal and objectively verifiable indicators, means of verification & assumptions.

• Visit a nearby KVKs / ATIC. Select any agriculture technology with package of practices and extension advisory services promoted by KVK / ATIC. Identify impact assessment indicators for social and behavioral indicators, socio-cultural indicators,technology level indicators, environmental impact assessment indicators and institutional impact assessment indicators.

• Refer any Environment Impact Assessment report and analyse steps in EIA. Write your observations.

Teaching methods/activities

– Lecture – Assignment (Reading/Writing)

– Student's Book/Publication Review

– Student presentation

– Group Work

– Guest Lectures

Learning outcome

After successful completion of this course, the students are expected to be able to: Develop competencies in the areas of evaluation planning, indicator development, conducting evaluation and impact assessment and writing reports.

Suggested Reading

Adrienne M, Gundel S, Apenteng E and Pound B. 2011. Review of Literature on Evaluation Methods Relevant to Extension. Lindau, Switzerland: Global Forum for Rural Advisory Services, Lindau, Switzerland Bagnol B. 2014. Conducting participatory monitoring and evaluation. Pages 81-85 in FAO, Decision tools for family poultry development. FAO Animal Production and Health Guidelines, No. 1 6. Rome, Italy: FAO. Bennett CF. 1979. Analyzing impacts of extension programs. Washington, D.C., USA: U.S. Department of Agriculture. Boyle R and Le Maire D. 1999. Building effective evaluation capacity: lessons from practice. New Brunswick, NJ: Transaction Publishers. Bradford RW, Duncan, P.J. and Tarcy, B. 1999. Simplified Strategic Planning: A No-nonsense Guide for Busy People Who Want Results Fast. New York: Chandler House. Braverman MT and Engle M. 2009. Theory and rigor in Extension program evaluation planning. Journal of Extension 47(3). www.joe.org/joe/2009june/a1.php Chen H. 2012. Theory-driven evaluation: Conceptual framework, application and advancement. In: Strobl R., Lobermeier O., Heitmeyer W. (eds) Evaluation von Programmen und Projekten für einedemokratische Kultur. Springer VS, Wiesbaden Chen, H.T. 2011. Practical program evaluation: Theory-Driven Evaluation and the Integrated Evaluation Perspective. Thousand Oaks, CA: Sage. Dale R. 2004. Evaluating Development Programmes and Projects, New Delhi, India: Sage Publications. Duncan Haughey 2017. SWOT Analysis. https://www.projectsmart.co.uk/swot-analysis.php. Fetterman, D.M. 2012. Empowerment Evaluation: Learning to think like an evaluator. In M.C. Alkin (Ed.), Evaluation Roots (2nd edition) (pp. 304-322). GFRAS. 2012. Guide to evaluating rural extension. Lindau, Switzerland: Global Forum for Rural Advisory Services (GFRAS). Greene, J.C., Boyce, A., and Ahn, J. (2011). A values-engaged educative approach for evaluating education programs: A guidebook for practice. Champaign, IL: University of Illinois at Urbana-

Practical

• Studies on kinds of nematodes- free-living, animal, insect and plant parasites;
• Nematode extraction from soil;
• Extraction of migratory endoparasites, staining for sedentary endoparasites;
• Examination of different life stages of important plant parasitic nematodes, their symptoms and histopathology.

Suggested Reading

Dropkin VH. 1980. An Introduction to Plant Nematology. John Wiley & Sons, New York. Maggenti AR. 1981. General Nematology. Springer-Verlag, New York. Perry RN and Moens M. 2013. Plant Nematology. 2nd Ed. CABI Publishing: Wallingford, UK. Perry RN, Moens M, and Starr JL. 2009. Root-knot nematodes, CABI Publishing: Wallingford, UK. Sikora RA, Coyne D, Hallman J and Timper P. 2018. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture.3rd edn. CABI Publishing, England. Thorne G. 1961. Principles of Nematology. McGraw Hill, New Delhi. Walia RK and Bajaj HK. 2003. Text Book on Introductory Plant Nematology. ICAR, New Delhi. Walia RK and Khan MR. 2018. A Compendium of Nematode Diseases of Crop Plants, ICARAICRP (Nematodes), IARI, New Delhi.

Course Title : Principles of Plant Pathology
Course Code : PL PATH 505
Credit Hours : 2+1
Aim of the course

To introduce the subject of Plant Pathology, its concepts and principles.

V. Theory

Unit I Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.

Unit II Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

Unit III Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens.

Unit IV Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

Practical

• Basic plant pathological techniques;
• Isolation, inoculation and purification of plant pathogens and proving Koch's postulates;
• Techniques to study variability in different plant pathogens;
• Purification of enzymes, toxins and their bioassay;
• Estimation of growth regulators, phenols, phytoalexins in resistant and susceptible plants.

Suggested Reading

Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York. Heitefuss R and Williams PH. 1976. Physiological Plant Pathology. Springer Verlag, Berlin, New York. Mehrotra RS and Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi. Singh RP. 2012. Plant Pathology 2nd edn. Kalyani Publishers, New Delhi. Singh RS. 2017. Introduction to Principles of Plant Pathology. 5th edn. MedTech, New Delhi. Singh DP and Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi. Upadhyay RK. and Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH, New Delhi.

Course Title : Techniques for Detection and Diagnosis of Plant Diseases
Course Code : PL PATH 506
Credit Hours : 0+2
Aim of the course

To impart training on various methods/ techniques/ instruments used in the study of plant diseases/ pathogens.

Practical

• Detection of plant pathogens
1. Based on visual symptoms, 2. Biochemical test 3.Using microscopic techniques, 4. Cultural studies; (use of selective media to isolate pathogens). 5. Biological assays (indicator hosts, differential hosts) 6. Serological assays 7. Nucleic acid based techniques (Non-PCR–LAMP, Later flow microarray and PCR based- multiplex, nested, qPCR, immune capture PCR, etc.);
• Phenotypic and genotypic tests for identification of plant pathogens;
• Molecular identification (16S rDNA and 16s-23S rDNA intergenic spacer region sequences-prokaryotic organisms; and eukaryotic organism by ITS region) and whole genome sequencing;
• Volatile compounds profiling by using GC-MS and LC-MS;

• FAME analysis, Fluorescence in-situ Hybridization (FISH), Flow Cytometry, Phage display technique, biosensors for detection of plant pathogens;
• Genotypic tools such as genome/ specific gene sequence homology comparison by BLAST (NCBI and EMBL) and electron microscopy techniques of plant virus detection and diagnosis.

Suggested Reading

Baudoin ABAM, Hooper GR, Mathre DE and Carroll RB. 1990. Laboratory Exercises in Plant Pathology: An Instructional Kit. Scientific Publ., Jodhpur. Dhingra OD and Sinclair JB. 1986. Basic Plant Pathology Methods. CRC Press, London, Tokyo. Fox RTV. 1993. Principles of Diagnostic Techniques in Plant Pathology, CABI Wallington. Forster D and Taylor SC. 1998. Plant Virology Protocols: From Virus Isolation to Transgenic Resistance. Methods in Molecular Biology. Humana Press, Totowa, New Jersey. Mathews REF. 1993. Diagnosis of Plant Virus Diseases. CRC Press, Boca Raton, Tokyo. Matthews REF. 1993. Diagnosis of Plant Virus Diseases. CRC Press, Florida. Noordam D. 1973. Identification of Plant Viruses, Methods and Experiments. Cent. Agic. Pub. Doc. Wageningen. Pathak VN. 1984. Laboratory Manual of Plant Pathology. Oxford & IBH, New Delhi. Trigiano RN, Windham MT and Windham AS. 2004. Plant Pathology-Concepts and Laboratory Exercises. CRC Press, Florida.Chakravarti BP. 2005. Methods of Bacterial Plant Pathology. Agrotech, Udaipur.

Note : For minor courses please refer the concerned department's courses outline

Course Title : Soil Fertility and Fertilizer Use
Course Code : Soil 502
Credit Hours : 3+1
Aim of the course
To impart knowledge about soil fertility and its control, and to understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.
Theory
Unit I
Soil fertility and soil productivity; fertility status of major soils group of India; nutrient sources – fertilizers and manures; Criteria of essentiality, classification, law of minimum and maximum, essential plant nutrients - functions and deficiency symptoms, Nutrient uptake, nutrient interactions in soils and plants; long term effect of manures and fertilizers on soil fertility and crop productivity.
Unit II Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation -types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.
Unit III Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid andalkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soilsand management under field conditions. Potassium - forms, equilibrium in soils and its agriculturalsignificance; mechanism of potassium fixation; management of potassium fertilizers under fieldconditions.
Unit V Sulphur - source, forms, fertilizers and their behavior in soils; roleincropsandhuman health; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.
Unit VI Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.
Unit VII Common soil test methods for fertilizer recommendations; quantity–intensityrelationships; soil test crop response correlations and response functions.

Unit VIII Fertilizer use efficiency; site-specific nutrient management; plant need based nutrient management; integrated nutrient management; speciality fertilizers concept, need and category. Current status of speciality fertilizers use in soils and crops of India;

Unit IX Soil fertility evaluation - biological methods, soil, plant and tissue tests; soilquality in relation to sustainable agriculture, Determination of critical limit, DRIS

Unit X Definition and concepts of soil health and soil quality; Longterm effects of fertilizers and soil quality.

Practical

- Soil and plant sampling and processing for chemical analysis
- Determination of soil pH, total and organic carbon in soil
- Chemical analysis of soil for total and available nutrients(major and micro)
- Analysis of plants for essential elements(major and micro)

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil fertility and fertilizers in relation to plant growth and development.

Suggested Reading

- Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.
- Kabata-Pendias A and Pendias H. 1992. Trace Elements in Soils and Plants. CRC Press.
- Kannaiyan S, Kumar K and Govindarajan K. 2004. Biofertilizers Technology. Scientific Publ.
- Leigh J G. 2002. Nitrogen Fixation at the Millennium. Elsevier.
- Mengel K and Kirkby EA. 1982. Principles of Plant Nutrition. International Potash Institute, Switzerland.
- Mortvedt JJ, Shuman LM, Cox FR and Welch RM. 1991. Micronutrients in Agriculture. 2nd Ed. SSSA, Madison.
- Pierzinsky GM, Sims TJ and Vance JF. 2002. Soils and Environmental Quality. 2nd Ed. CRC Press.
- Stevenson FJ and Cole MA. 1999. Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.

• Identification and quantification of minerals in soil fractions
• Morphological properties of soil profile in different land forms
• Classification of soils using soil taxonomy
• Calculation of weathering indices and its application in soil formation
• Grouping soil susing available database in terms of soil quality

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil taxonomy and genesis and and their utility in research for solving field problem.

Suggested Reading

• Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu. Buol EW, Hole ED, MacCracken RJ and Southard RJ. 1997. Soil Genesis • and Classification. 4th Ed. Panima Publ.
• Dixon JB and Weed SB. 1989. Minerals in Soil Environments. 2nd Ed. Soil Science Society of America, Madison.
• Grim RE. 1968. Clay Mineralogy. McGraw Hill.
• Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi. • Sehgal J. 2002. Introductory Pedology: Concepts and Applications. New Delhi
• Sehgal J. 2002. Pedology - Concepts and Applications. Kalyani.
• USDA. 1999. Soil Taxonomy. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.
• Wade FA and Mattox RB. 1960. Elements of Crystallography and Mineralogy. Oxford & IBH. • Wilding LP and Smeck NE. 1983. Pedogenesis and Soil Taxonomy: II. The Soil Orders. Elsevier.
• Wilding NE and Holl GF. (Eds.). 1983. Pedogenesis and Soil Taxonomy. I.

Course Title : Soil Erosion and Conservation
Course Code : Soil 505
Credit Hours : 2+1

Aim of the course

To enable students to understand various types of soil erosion and measures to betaken for controlling soil erosion to conserve soil and water.

Theory

Unit I History, distribution, identification and description of soil erosionproblems in India.

Unit II Forms of soil erosion; effects of soil erosion and factors affecting soilerosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI30 index and kinetic energy; factors affectingwater erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

Unit III Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.

Unit IV Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.

Unit V Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

Unit VI Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds, sediment measurement

Practical

• Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index

• Computation of kinetic energy of falling rain drops

• Computation of rainfall erosivity index (EI30) using rain gauge data

• Land capability classification of a watershed

• Visits to a watersheds

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil conservation and their utility in research for solving field problem.

Suggested Reading

• Biswas TD and Narayanasamy G. (Eds.) 1996. Soil Management in Relation to Land Degradation and Environment. Bull. Indian Society of Soil Science No. 17.
• Doran JW and Jones AJ. 1996. Methods of Assessing Soil Quality. Soil Science Society of America, Spl Publ. No. 49, Madison, USA.
• Gurmal Singh, Venkataramanan C, Sastry G and Joshi BP. 1990. Manual of Soil and Water Conservation Practices. Oxford & IBH.
• Hudson N. 1995. Soil Conservation. Iowa State University Press.
• Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi. • Oswal MC. 1994. Soil Physics. Oxford & IBH.

Course Title : Soil Biology and Biochemistry
Course Code : Soil 506
Credit Hours : 2+1
Aim of the course
To teach students the basics of soil biology and biochemistry, including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.
Theory
Unit I Soilbiota, soil microbialecology, types of organisms indifferent soils; soil microbial biomass; microbial interactions; un-culturable soilbiota.
Unit II Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora; Root rhizosphere and PGPR.
Unit III Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and cropresidues, microbiology and biochemistry of decomposition of carbonaceous and protenaceous materials, cycles of important organic nutrients. **Unit IV** Organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.
Unit V Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost.
Unit VI Biofertilizers–definition, classification, specifications, method of production and role in crop production; FCO specifications and quality control of biofertilizers.
Unit VII Biological indicators of soil quality; bioremediation of contaminated soils; microbial transformations of heavy metals in soil; role of soil organisms inpedogenesis – important mechanisms and controlling factors; soil genomics

and bioprospecting; soil sickness due to biological agents; xenobiotics; antibiotic production in soil.

Practical

• Determination of soil microbial population
• Soil microbial biomass carbon
• Elemental composition, fractionation of organic matter and functional groups
• Decomposition of organic matter in soil
• Soil enzymes
• Measurement of important soil microbial processes such as ammonification, nitrification, N2 fixation, S oxidation, P solubilization and mineralization of other micronutrients

Teaching methods/ activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil microbes and their utility in research for solving field problem.

Suggested Reading

• Paul EA and Clark FE. Soil Microbiology and Biochemistry.
• Lynch JM. Soil Biotechnology
• Willey JM, Linda M. Sherwood and Woolverton CJ. Prescott's Microbiology.
• Subba Rao NS. Advances In Agricultural Microbiology.

Course Title : Soil Survey and Land Use Planning
Course Code : Soil 513
Credit Hours : 2+0
im of the course

To teach the better utilization of land for agricultural purposes, and better management of run-off or surplus/ excessive rain-water in the catchment area for agricultural purposes in a watershed.

V. Theory

Unit I

Soil survey and its types; soil survey techniques- conventional and modern; soil series–characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; thematic soil maps, cartography, mapping units, techniques for gene ration of soil maps,

application of remote sensing and GIS in soil survey and mapping of major soil group of India

Unit II

Landform–soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT)–concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

Unit III

Concept and techniques of land use planning; factors governing present land use; Land evaluation method sand soil-site suitability evaluation for different crops; land capability classification and constraints in application.

Unit IV

Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production. Status of LUP in India.

VI. Practical

• Aerial photo and satellite data interpretation for soil and land use

• Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in differentscales

• Land use planning exercises using conventional and RS tools

VII. Teaching methods/activities

Classroom teaching with AV aids, group discussion, field visit and exposure visit

VIII. Learning outcome

Planning for land use in proper way for higher crop productivity.

IX. Suggested Reading

• Boul SW, Hole ED, MacCraken RJ and Southard RJ. 1997. Soil Genesis and Classification. 4th Ed. Panima Publ.

• Brewer R. 1976. Fabric and Mineral Analysis of Soils. John Wiley & Sons.

Note : For minor courses please refer the concerned department's courses outline.

MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Course Contents M.Sc. in Molecular Biology and Biotechnology

I. Course Title : Principles of Biotechnology

II. Course Code : MBB 501

III. Credit Hours : 3+0

IV. Aim of the course

• To understand the basics of Molecular biology, plant and microbial Biotechnology

• Importance and applications in agriculture, case studies and success stories

• Public education, perception, IPR and related issues

V. Theory

Unit I (12 Lectures) History, scope and importance of Biotechnology; Specializations in Agricultural Biotechnology: Genomics, Genetic engineering, Tissue Culture, Bio-fuel, Microbial Biotechnology, Food Biotechnology etc. Basics of Biotechnology, Primary metabolic pathways, Enzymes and its activities.

Unit II (16 Lectures) Structure of DNA, RNA and protein, their physical and chemical properties. DNA function: Expression, exchange of genetic material, mutation. DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; DNA/RNA libraries; Applications of gene cloning in basic and applied research, Plant transformation: Gene transfer methods and applications of GM crops.

Unit III (8 Lectures) Molecular analysis of nucleic acids -PCR and its application in agriculture and industry, Introduction to Molecular markers: RFLP, RAPD, SSR, SNP etc, and their applications; DNA sequencing, different methods; Plant cell and tissue culture techniques and their applications.Introduction to genomics, transcriptomics, ionomics, metabolomics and proteomics. Plant cell and tissue culture techniques and their applications.

Unit IV (12 Lectures) Introduction to Emerging topics: Genome editing, gene silencing, Plant microbial interactions,Success stories in Biotechnology,

Careers and employment in biotechnology. Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

VI. Suggested Reading

• Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R. 2014. Molecular Biology of the Gene, 7th edition, Cold Spring Harbor Laboratory Press, New York • Brown T A. 2010. Gene Cloning and DNA analysis an Introduction 6th edition, Wiley Blackwell • Primrose SB and Twyman R. 2006. Principles of gene Manipulation 7th edition, Wiley Blackwell • Singh BD. 2012. Biotechnology: Expanding Horizons 4th edition, Kalyani publisher, New Delhi, India

Course Title : Fundamentals of Molecular Biology

Course Code : MBB 502

Credit Hours : 3+0

Aim of the course

• To understand the basics of DNA, RNA, structure, types and chromatin assembly.

• To get insights into the Central Dogma, basic cellular processes, role of mutation and recombination.

• To understand different levels of gene regulation and the pathways involved.

Theory

Unit I (8 Lectures) Historical developments of molecular biology, Nucleic acids as genetic material, Chemistry and Nomenclature of nucleic acids; Structure of DNA: primary structure; secondary structure, Forms of DNA: A,B, Z and their function; Structure andTypes of RNA Genome organization in prokaryotes and eukaryotes; DNA Topology; DNA re-association kinetics, Types of repeat sequences.

Unit II (10 Lectures) Central dogma of Molecular Biology; DNA replication-Classical experiments, Models of DNA replication; DNA replication, Origin and Steps in DNA replication - initiation, elongation and termination; Enzymes and accessory proteins and its mechanisms; Eukaryotic DNA replication in

• Class room Lectures

• Laboratory/ Field Practicals

• Student Seminars/ Presentations

• Field Tours/ Demonstrations

• Assignments

Learning outcome

The student would be expected to equip to acquire skills and knowledge on principles and practices of macro and micropropagation and the handling of propagated material in nursery. X. Suggested Reading Bose TK, Mitra SK and Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkatta. Davies FT, Geneve RL and Wilson SB. 2018. Hartmann and Kester's Plant PropagationPrinciples and Practices. Pearson, USA/ PrenticeHall of India. New Delhi. Gill SS, Bal JS and Sandhu AS. 2016. Raising Fruit Nursery. Kalyani Publishers,New Delhi. Jain S and Ishil K. 2003. Micropropagation of Woody Trees and Fruits. Springer. Jain S and Hoggmann H. 2007. Protocols for Micropropagation of Woody Trees and Fruits. Springer. Joshi P. 2015. Nursery Management of Fruit Crops in India. NIPA, New Delhi. Love et al. 2017. Tropical Fruit Tree Propagation Guide. UH-CTAHR F_N_49. College of Tropical Agriculture and Human Resources University of Hawaii at Manwa, USA. Peter KV, eds. 2008. Basics of Horticulture. New India Publishing Agency, New Delhi. Rajan S and Baby LM. 2007. Propagation of Horticultural Crops. NIPA, New Delhi. Sharma RR. 2014. Propagation of Horticultural Crops. Kalyani Publishers, New Delhi. Sharma RR and Srivastav M. 2004. Propagation and Nursery Management. Intl. Book Publishing Co., Lucknow. Singh SP. 1989. Mist Propagation. Metropolitan Book Co. Singh RS. 2014. Propagation of Horticultural Plants: Arid and Semi-Arid Regions. NIPA, New Delhi. Tyagi S. 2019. Hi-Tech Horticulture. Vol I: Crop Improvement, Nursery and Rootstock Management. NIPA, New Delhi.

Course Title : Breeding of Fruit Crops

Course Code : FSC 504

Credit Hours : (2+1)

Why this course ?

Development of genetically improved varieties and rootstock is a continuous process which is realized through selection and breeding approaches. This is necessary to enhance the productivity and meet ever-changing climatic conditions and market/ consumer preferences. As such, a course is formulated to generate know-how on genetic and breeding aspects of fruit crops.

Aim of the course

To impart comprehensive knowledge on principles and practices of fruit breeding.

The course organisation is as under:

No.	Blocks	Units
1	Introduction	Importance, Taxonomy and Genetic Resources
2	Reproductive Biology	Blossom Biology and Breeding Systems
3	Breeding approaches	Conventional and Non-Conventional Breeding

Theory

Block 1: Introduction

Unit I:

Importance, Taxonomy and Genetic Resources: Introduction and importance, origin and distribution, taxonomical status – species and cultivars, cytogenetics, genetic resources.

Block 2: Reproductive Biology

Unit I:

Blossom Biology and Breeding Systems: Blossom biology, breeding systems – spontaneous mutations, polyploidy, incompatibility, sterility, parthenocarpy, apomixis, breeding objectives, ideotypes.

Block 3: Breeding Approaches

Unit I:

Conventional and Non-Conventional Breeding: Approaches for crop improvement – direct introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrusts. Crops Mango, Banana, Pineapple, Citrus, Grapes, Litchi, Guava, Pomegranate, Papaya, Apple, Pear, Plum, Peach, Apricot, Cherries, Strawberry, Kiwifruit, Nuts

Practicals

• Exercises on bearing habit, floral biology (2);

• Pollen viability and fertility studies (1);

• Hands on practices in hybridization (3);

• Raising and handling of hybrid progenies (2);

• Induction of mutations and polyploidy (2);

• Evaluation of biometrical traits and quality traits (2);

• Screening for resistance against abiotic stresses (2);

• Developing breeding programme for specific traits (2);

• Visit to research stations working on fruit breeding (1).

Teaching Methods/ Activities

• Class room Lectures

• Laboratory/ Field Practicals

• Student Seminars/ Presentations

• Field Tours/ Demonstrations

• Assignments

Learning outcome

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

• Have an understanding on importance and peculiarities of fruit breeding

• Have an updated knowledge on reproductive biology, genetics and inherent breeding systems.

• Have detailed knowledge of various methods/ approaches of breeding fruit crops

Suggested Reading

Abraham Z. 2017. Fruit Breeding. Agri-Horti Press, New Delhi. Badenes ML and Byrne DH. 2012. Fruit Breeding. Springer Science, New York. Dinesh MR. 2015. Fruit Breeding, New India Publishing Agency, New Delhi. Ghosh SN, Verma MK and Thakur A. 2018. Temperate Fruit Crop Breeding-Domestication to Cultivar Development. NIPA, New Delhi. Hancock JF. 2008. Temperate Fruit Crop Breeding: Germplasm to Genomics. Springer Science, New York. Jain SN and Priyadarshan PM. 2009. Breeding Plantation and Tree Crops: Tropical Species. Springer Science, New York. Jain S and Priyadarshan PM. 2009. Breeding Plantation and Tree Crops: Temperate Species. Springer Science, New York. Janick J and Moore JN. 1996. Fruit Breeding. Vols. I–III. John Wiley & Sons, USA. Kumar N. 2014. Breeding of Horticultural Crops:Principles and Practices. NIPA, N. Delhi. Moore JN and Janick J. 1983. Methods in Fruit Breeding. Purdue University Press, USA. Ray PK. 2002. Breeding Tropical and Subtropical Fruits. Narosa Publ. House, New Delhi.

Course Title : Canopy Management of Fruit Crops

Course Code : FSC 506

Credit Hours : (1+1)

2006. High Density Planting in Tropical Fruits: Principles and Practices. IBDC Publishers, New Delhi. Pradeepkumar T. 2008. Management of Horticultural Crops. NIPA, New Delhi. Singh G. 2010. Practical Manual on Canopy Management in Fruit Crops. Dept. of Agriculture and Co-operation, Ministry of Agriculture (GoI), New Delhi. Srivastava KK. 2012. Canopy Management in Fruits. ICAR, New Delhi

Course Title : Growth and Development of Fruit Crops

Course Code : FSC 507

Credit Hours : (2+1)

Why this course ?

The underlying principles and parameters of growth and development needs to be understood for harnessing maximum benefits in term of yield and quality. External environment and inherent hormonal and metabolic pathways considerably determine growth dynamics. Thus, a course is formulated to develop know-how on physiological and physical aspects of growth and development processes.

Aim of the course

To develop comprehensive understanding on growth and development of fruit crops.

The course is structured as under:-

No.	Blocks	Units
1	Introduction	General Concepts and Principles
2	Environment and Development	Climatic Factors, Hormones and Developmental Physiology
3	Stress Management	Strategies for Overcoming Stress

Theory

Block 1: Introduction

Unit I: General

Concepts and Principles: Growth and development- definition, parameters of growth and development, growth dynamics and morphogenesis.

Block 2: Environment and Development

Unit I:

Climatic Factors, Hormones and Developmental Physiology: Environmental impact on growth and development- effect of light, temperature, photosynthesis and photoperiodism, vernalisation, heat units and thermoperiodism. Assimilate partitioning, influence of water and mineral nutrition in growth and development; concepts of plant hormone and bioregulators, history, biosynthesis and physiological role of auxins, gibberellins, cytokinins, abscissic acid, ethylene, growth inhibitors and retardant, brasssinosteroids, other New PGRs. Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.

Block 3: Stress Management

Unit I:

Strategies for Overcoming Stress: Growth and developmental process during stress – manipulation of growth and development, impact of pruning and training, chemical manipulations and Commercial application of PGRs in fruit crops, molecular and genetic approaches in plant growth and development.

Practicals

• Understanding dormancy mechanisms in fruit crops and seed stratification (2);

• Techniques of growth analysis (2);

• Evaluation of photosynthetic efficiency under different environments (2);

• Exercises on hormone assays (2);

• Practicals on use of growth regulators (2);

• Understanding ripening phenomenon in fruits (2);

• Study on impact of physical manipulations on growth and development (1);

• Study on chemical manipulations on growth and development (1);

• Understanding stress impact on growth and development (1).

Teaching Methods/ Activities

• Class room Lectures

• Laboratory/ Field Practicals

• Student Seminars/ Presentations

• Field Tours/ Demonstrations

• Assignments

Learning outcome

Consequent upon successful completion of the course, the students are expected to have

• Equipped with understanding of various growth and development processes

• Learned about the role of environment and growth substances

• Acquired the skills to realise optimum growth and development under stress conditions

Suggested Reading

Bhatnagar P. 2017. Physiology of Growth and Development of Horticultural Crops. Agrobios (India). Buchanan B, Gruiessam W and Jones R. 2002. Biochemistry and Molecular Biology of Plants. John Wiley & Sons, NY, USA. Dhillon WS and Bhatt ZA. 2011. Fruit Tree Physiology. Narendra Publishing House, New Delhi. Durner E. 2013. Principles of Horticultural Physiology.

Biotechnology of Vegetables. New India Publishing Agency, Pritam Pura, New Delhi. Saini et al. (Eds.). 2001. Laboratory manual of analytical techniques in horticulture. Agrobios, Jodhpur. Wien HC. (Eds.). 1997. The physiology of vegetable crops. CAB International.

Course Title : Principles of Vegetable Breeding

Course Code : VSC 504

Credit Hours : (2+1)

Why this course ?

Plant breeding has been practiced for thousands of years, since beginning of human civilization. Vegetable breeding, which is an art and science of changing the traits of plants in order to produce desired traits, has been used to improve the quality of nutrition in products for human beings. A breeding programme, which is needed if current varieties are not producing up to the capacity of the environment, can be accomplished through many different techniques ranging from simply selecting plants with desirable characteristics, make use of knowledge of genetics and chromosomes to more complex molecular techniques. When different genotypes exhibit differential responses to different sets of environmental conditions, a genotype x environment (GxE) interaction is said to occur. Breeding high yielding open pollinated varieties and hybrids, and exploitation of location specific component of genotypic performance are the only options left to reduce this increasing gap between the production and requirements in view of decreasing land resources. Noevertheless, vegetable breeding is an integral part of plant breeding but this will be re-modeled to suit to breeding of different vegetables crops. The students of vegetable science who are having breeding as major subject need to have an understanding of vegetable breeding principles.

Aim of the course

To teach basic principles and practices of vegetable breeding

The course is constructed given as under:

No.	Block	Unit
1.	Principles of vegetable breeding	I. Importance and history II. Selection procedures III. Heterosis breeding IV. Mutation breeding V. Polyploid breeding VI. Ideotype breeding

Theory

Unit I

Importance and history- Importance, history and evolutionary aspects of vegetable breeding and its variation from cereal crop breeding.

Unit II

Selection procedures- Techniques of selfing and crossing; Breeding systems and methods; Selection procedures and hybridization; Genetic architecture; Breeding for biotic stress (diseases, insect pests and nematode), abiotic stress (temperature, moisture and salt) resistance and quality improvement; Breeding for water use efficiency (WUE) and nutrients use efficiency (NUE).

Unit III

Heterosis breeding- Types, mechanisms and basis of heterosis, facilitating mechanisms like male sterility, self-incompatibility and sex forms.

Unit IV

Mutation and Polyploidy breeding; Improvement of asexually propagated vegetable crops and vegetables suitable for protected environment.

Unit V

Ideotype breeding- Ideotype breeding; varietal release procedure; DUS testing in vegetable crops; Application of In-vitro and molecular techniques in vegetable improvement.

Practical

• Floral biology and pollination behaviour of different vegetables;
• Techniques of selfing and crossing of different vegetables, viz., Cole crops, okra, cucurbits, tomato, eggplant, hot pepper, etc.;
• Breeding system and handling of filial generations of different vegetables;
• Exposure to biotechnological lab practices;
• Visit to breeding farms.

Teaching Methods/ Activities

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

Learning outcome

After successful completion of this course, the students are expected to:
• Acquire knowledge about the principles of vegetable breeding

• Improve yield, quality, abiotic and biotic resistance, other important traits of vegetable crops
• Understand how the basic principles are important to start breeding of vegetable crops

Suggested Reading

Allard RW. 1960. Principle of plant breeding. John Willey and Sons, USA. Kalloo G. 1988. Vegetable breeding (Vol. I, II, III). CRC Press, Fl, USA. Kole CR. 2007. Genome mapping and molecular breeding in plants-vegetables. Springer, USA. Peter KVand Pradeep Kumar T. 1998. Genetics and breeding of vegetables. ICAR, New Delhi, p. 488. Prohens J and Nuez F. 2007. Handbook of plant breeding-vegetables (Vol I and II). Springer, USA. Singh BD. 2007. Plant breeding- principles and methods (8th edn.). Kalyani Publishers, New Delhi. Singh Ram J. 2007. Genetic resources, chromosome engineering, and crop improvement-vegetable crops (Vol. 3). CRC Press, Fl, USA.

Course Title : Protected Cultivation of Vegetable CropS

Course Code : VSC 507

Credit Hours : (2+1)

Why this course ?

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

and plays an important role in the foreign trade balance of several national economies. The students of vegetable science need to have an understanding of protected cultivation of vegetable crops.

Aim of the course

To impart latest knowledge about growing of vegetable crops under protected environmental conditions

The course is constructed given as under:

No.	Block	Unit
1.	Protected cultivation of vegetable	I. Scope and importance crops II. Types of protected structure III. Abiotic factors IV. Nursery raising V. Cultivation of crops VI. Solutions to problems

Theory

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Unit VI

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

Practical

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

VIII. Teaching Methods/ Activities

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

Learning outcome

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

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

Suggested Reading

HORTICULTURE (PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS)

I. Course Title : Production of Plantation Crops
II. Course Code : PSM 501
III. Credit Hours : (2+1)
IV. Why this course ?
Plantation crops play an important role in the national economy of India. These crops also provide livelihood security to a large section of farmers. This course willimpart theoretical as well as hands-on experience to the learner on scientificproduction technology of various plantation crops in Indian perspectives. It willprovide comprehensive knowledge in this regard.
V. Aim of the course
The course is designed to provide both basic and applied knowledge on various aspects of production technology of plantation crops grown in India.
The course is organized as follows:

No	Blocks	Units
1	Importance of Plantation Crops	I Role of plantation crops
		II Export potential
		III Promotional programmes
2	Production Technology	I Varietal wealth
		II Propagation and nursery management
		III Agro techniques
3	Harvest and Post-harvest management	I Maturity indices and harvest
		II Post harvest management

VI. Theory
Block 1: Importance of Plantation Crops
Unit 1: Role of plantation crops: Role of plantation crops in national economy, area-production statistics at national and international level,classification, clean development mechanism and carbon sequestrationpotential of plantation crops.
Unit 2: Export potential: Export potential, problems and prospects and IPR issues in plantation crops.
Unit 3: Promotional programmes: Role of commodity boards and directorates in the development programmes of plantation crops.
Block 2: Production Technology

Unit 1: Varietal wealth: Botany, taxonomy, species, cultivars and improved varieties in plantation crops.
Unit 2: Propagation and nursery management: Plant multiplication including *in-vitro*multiplication, nursery techniques and nursery management in plantation crops.
Unit 3: Agro techniques: Systems of cultivation, cropping systems, multitiercropping, climate and soil requirements, systems of planting, high densityplanting, nutritional requirements, water requirements, fertigation,moisture conservation, role of growth regulators, macro and micronutrients, nutrient deficiency symptoms, physiological disorders, shaderegulation, weed management, training and pruning, crop regulation,plant protection, management of drought, precision farming.

Block 3: Harvest and Post harvest management

Unit 1: Maturity indices and harvest: Maturity indices, harvesting methods,harvesting seasons and mechanized harvesting in plantation crops.
Unit 2: Post harvest management: Post harvest handling including primaryprocessing, grading, packaging, storage and benefit cost analysis ofplantation crops.

Crops

Coconut, Arecanut, Oilpalm, Cashew, Coffee, Tea, Cocoa, Rubber, Palmyrah, Betel vine

VII. Practical

- Description of botanical and varietal features;
- Selection of mother palms and seedlings;
- Nursery techniques;
- Soil and water conservation measures;
- Nutrient deficiency symptoms;
- Manuring practices;
- Pruning and training methods;
- Maturity standards;
- Harvesting;
- Project preparation for establishing plantations;
- GAP in plantation crops;
- Exposure visits to commercial plantations, research institutes.

VIII. Teaching Methods/ Activities

- Lecture
- Assignment (Reading/ Writing)

• Demonstration
• Exposure visits

IX. Learning outcome

After successful completion of this course, the students are expected to:
• Develop the technical skill in commercial cultivation of plantation crops
• Be able to start plantation crop-based enterprises

X. Suggested Reading

Afoakwa EO. 2016. *Cocoa Production and Processing Technology*. CRC Press.
Anonymous. 1985. *Rubber and its Cultivation*. The Rubber Board of India.
Chopra VL and Peter KV. 2005. *Handbook of Industrial Crops*. Panima.
Choudappa P, Anitha K, Rajesh MK and Ramesh SV. 2017. *Biotechnology of Plantation Crops*.
Daya Publishing House, New Delhi
Choudappa P, Niral V, Jerard BA and Samsudeen K. 2017. *Coconut*. Daya Publishing House,
New Delhi.
*e-manual*on Advances in Cashew Production Technology. ICAR –Directorate of Cashew
Research, Puttur –574 202, DK, Karnataka.
Harler CR. 1963. *The Culture and Marketing of Tea*. Oxford Univ. Press.
Joshi P. 2018. *Text Book on fruit and plantation crops*. Narendra Publishing House, New Delhi
Kurian A and Peter KV. 2007. *Commercial Crops Technology*. New India Publ. Agency.
Nair MK, Bhaskara Rao EVV, Nambia KKN and Nambiar MC. 1979. *Cashew*. CPCRI,
Kasaragod.
Panda H. 2013. *The Complete Book on Cashew*. Asia Pacific Business Press Inc.
Panda H. 2016. *The Complete Book on Cultivation and Manufacture of Tea* (2nd Revised Edition).
Asia Pacific Business Press Inc.
Peter KV. 2002. *Plantation Crops.* National Book Trust.
Pillay PNR. 1980. *Handbook of natural rbber production in India*. Rubber Research Institute,
Kottayam. pp.668.

Pradeepkumar T, Suma B, Jyothibhaskar and Satheesan KN. 2007. *Management of*
Horticultural Crops. Parts I, II. New India Publ. Agency.
Ramachandra *et al.* 2018. *Breeding of Spices and Plantation crops*. Narendra Publishing House,
New Delhi.
Ranganathan V. 1979. *Hand Book of Tea Cultivation.* UPASI, Tea Res. Stn. Cinchona.
Sera T, Soccol CR, Pandey A, Roussos S *Coffee Biotechnology and Quality*. Springer, Dordrecht.
Sethuraj MR and Mathew NT. 1992. *Natural Rubber: Biology, Cultivation and Technology*
(Developments in Crop Science). Elsevier Science.
Sharangi AB and Datta S. 2015. *Value Addition of Horticultural crops: Recent trends and*
Future directions. SPRINGER; ISBN: 978-81-322-2261-3.
Sharangi AB and Acharya SK. 2008. *Quality management of Horticultural crops*. Agrotech
Publishing House, Udaipur; ISBN: 81-8321-090-2.
Srivastava HC, Vatsaya and Menon, KKG. 1986. *Plantation Crops – Opportunities and*
Constraints. Oxford and IBH.
Thampan PK. 1981. *Hand Book of Coconut Palm*. Oxford and IBH.

I. Course Title : Production of Spice Crops
II. Course Code : PSM 502
III. Credit Hours : (2+1)
IV. Why this course ?
Spice crops play an important role in the national economy of India. These cropsalso provide livelihood security to a large section of farmers. This course willimpart theoretical as well as hands-on experience to the learner on scientificproduction technology of various spice crops in Indian perspectives. It will providecomprehensive knowledge in this regard.
V. Aim of the course
The course is designed to provide both basic and applied knowledge on variousaspects of production technology of spice crops grown in India.The course is organized as follows:

No	Blocks	Units
1	Importance of Spice Crops	I Role of spice crops
		II Classification of spice crops
2	Production Technology	I Varietal wealth
		II Propagation and nursery management
		III Agro techniques
3	Harvest and Post harvest management	I Maturity indices and harvest
		II Post harvest management

VI. Theory

Block 1: Importance of spice crops

Unit 1: Role of Spice crops: Introduction, importance of spice crops,pharmaceutical significance, historical accent, present status – national and international, future prospects, role of Spices board and otherdevelopment agencies.

Unit 2: Classification of spice crops: Major spices, minor spices, seed spices,tree spices, herbal spices.

Block 2: Production Technology

Unit 1: Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in spice crops.

Unit 2: Propagation and nursery management: Seed, vegetative and micropropagationmethods, nursery techniques and nursery managementpractices.

Unit 3: Agro techniques: Climatic and soil requirements, site selection, layout, sowing/ planting times and methods, seed rate and seed treatment,nutritional and irrigation requirements, intercropping, mixed cropping,intercultural operations, weed control, mulching, plant protection,precision farming, physiological disorders, protected cultivation.

Block 3: Harvest and Post harvest management

Unit 1: Maturity indices and harvest: Maturity indices, harvesting methods,harvesting seasons, mechanized harvesting.

Unit 2: Post harvest management: Post harvest management including primaryprocessing, grading, packaging and storage, GMP in major spice crops.

Crops

Black pepper, small and large Cardamom, Turmeric, Ginger, Garlic, Coriander,

Fenugreek, Cumin, Fennel, Ajwain, Saffron, Vanilla, Nutmeg, Clove, Cinnamon,Allspice, Tamarind, Garcinia

VII. Practical

• Identification of seeds and plants;
• Botanical description of plant;
• Varietal features;
• Planting material production;
• Field layout and method of planting;
• Cultural practices;
• Harvest maturity, harvesting;
• Drying, storage, packaging;
• Primary processing;
• GAP in spice crops;
• GMP in spice crops;
• Short term experiments on spice crops;
• Exposure visits to spice farms, research institutes.

VIII. Teaching Methods/ Activities

• Lecture
• Assignment (Reading/ Writing)
• Demonstration
• Exposure visits

IX. Learning outcome

After successful completion of this course, the students are expected to:
• Develop the technical skill in commercial cultivation of spice crops
• Be able to start spice-based enterprises

X. Suggested Reading

Agarwal S, Sastry EVD and Sharma RK. 2001. *Seed Spices: Production, Quality, Export.* Pointer
Publ.
Arya PS. 2003. *Spice Crops of India.* Kalyani.
Bose TK, Mitra SK, Farooqi SK and Sadhu MK. Eds. 1999. *Tropical Horticulture.* Vol.I. Naya
Prokash.
Chadha KL and Rethinam P. Eds. 1993. *Advances in Horticulture.* Vols. IX-X. *Plantation Crops*
and Spices. Malhotra Publ. House.

Sharma G. 2009. *Systematics of fruit Crops*. New India Publishing House, India.
Strickberger MW. 2005. *Genetics* (III Ed). Prentice Hall, New Delhi, India
Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publishers

I. Course Title : Growth and Development of Plantation, Spice, Medicinal and Aromatic Crops
II. Course Code : PSM 509
III. Credit Hours : (2+1)
IV. Why this course ?
Understanding on growth and development of plantation, spice, medicinal and aromatic crops is vital towards quality production as well as yield. Fundamentalknowledge on developmental physiology, biology and biochemistry and the associatedchanges is most essential. This course will impart theoretical as well as hands-onexperience to the learner on these aspects of PSMA crops for improving theirproductivity.
V. Aim of the course
To impart comprehensive knowledge on the growth, developmental stages and cropregulation to increase the productivity in PSMAs
The course is organized as follows:

No	Blocks	Units
1	Growth and development	I Stages of growth
		II Growth pattern
		III Assimilate partitioning
2	Canopy management	I Canopy management
		II Plant bio regulators
3	Developmental physiology and biochemistry	I Vegetative phase
		II Flowering and fruit set
		III Growth and development during stress

VI. Theory
Block 1: Growth, development, assimilate partitioning and plant bio regulators
Unit I: Stages of growth: Growth and development, definitions, components,photosynthetic productivity, different stages of growth, growth curves,growth analysis, morphogenesis in PSMAs.
Unit II: Growth pattern: in annual, semi-perennial and perennial crops, growth dimorphism, environmental impact on growth and development: effectof light, temperature, photoperiod.

Unit III: Assimilate partitioning: Assimilate partitioning during growth and development, influence of water and mineral nutrition.

Block 2: Canopy management

Unit I: Canopy management: Canopy management for conventional and high density planting pruning, training, chemicals, crop regulation for yearround and off season production in PSMAs.

Unit II: Plant bio regulators: plant bio regulators- auxins, gibberellins,cytokinins, ethylene, inhibitors and retardants, basic functions,biosynthesis and role in crop growth and development.

Block 3: Developmental physiology and biochemistry

Unit I: Vegetative phase: Developmental physiology and biochemistry during dormancy, bud break, juvenility.

Unit II: Flowering and fruit set

Physiology of flowering, photoperiodism, vernalisation, effect of temperature, heat units, thermoperiodism, pollination, fertilisation, fruit set, fruit drop, fruit growth, ripening, seed development in PSMAs.

Unit III: Growth and development process during stress: Growth and development process during stress, production of secondary metabolites, molecular and genetic approaches in growth and development.

VII. Practical

- Dormancy mechanisms in seeds, seed rhizomes;
- Techniques of growth analysis;
- Evaluation of photosynthetic efficiency under different environments;
- Technologies for crop regulation in cashew, coffee, cocoa, etc.;
- Root shoot studies, flower thinning, fruit thinning;
- Crop regulation for year round production;
- Use of growth regulators in PSMA crops.

VIII. Teaching Methods/ Activities

- Lectures
- Assignments (Reading/ Writing)
- Demonstrations
- Exposure visits

IX. Learning outcome

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

- have thorough understanding on growth and development of PSMA crops
- will enable them to formulate crop regulation strategies for productivity

enhancement.

X. Suggested Reading

Afoakwa EO. 2016. *Cocoa Production and Processing Technology*. CRC Press
Buchanan BW. Gruiessam and Jones, R. 2002. *Biochemistry and Molecular Biology of Plants*.
John Wiley and Sons.
*E- manual*on Advances in Cashew Production Technology. ICAR -Directorate of Cashew
Research, Puttur –574 202, DK, Karnataka
Epstein E. 1972. *Mineral Nutrition of Plants: Principles and Perspectives*.Wiley.
Fosket DE. 1994. *Plant Growth and Development: A Molecular approach*. Academic Press.
Leoplod AC and Kriedermann PE. 1985. *Plant Growth and Development.* 3rdEd.McGraw-Hill
Panda H. 2013. *The Complete Book on Cashew*. Asia Pacific Business Press Inc.
Panda H. 2016. *The Complete Book on Cultivation and Manufacture of Tea* (2nd Revised Edition).
Asia Pacific Business Press Inc.
Pillay PNR. 1980. *Handbook of Natural Rubber Production in India.* Rubber Research Institute,
Kottayam. pp.668
Ravindran PN. 2000. *Black pepper, Piper nigrum*. CRC press
Ravindran PN. 2002. *Cardamom, the genus Elettaria*. CRC press
Ravindran PN. 2003. *Cinnamon and cassia.* CRC press
Ravindran PN. 2004. *Ginger, the genus Zingiber*. CRC press
Ravindran PN. 2007. *Turmeric, the genus curcuma*. CRC press
Ravindran PN. 2017. *The Encyclopedia of Herbs and Spices*. CABI
Roberts JS Downs and P Parker. 2002. *Plant Growth Development*. In: *Plants* (L. Ridge, Ed.),
pp. 221-274, Oxford University Press
Salisbur FB and Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.
Sera T, Soccol CR, Pandey A. and Roussos S. *Coffee Biotechnology and Quality*. Springer,
Dordrecht.

HORTICULTURE (PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS)

PSMA 501 Production of Plantation Crops 2+1

Objective

To impart basic knowledge about the importance and production technology of plantation crops grown in India.

Theory

Role of plantation crops in national economy, export potential, IPR issues, clean development mechanism, classification and varietal wealth. Plant multiplication including *in vitro* multiplication, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micro nutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting. Cost benefit analysis, organic farming, management of drought, precision farming.

Crops

UNIT I: Coffee and tea

UNIT II: Cashew and cocoa

UNIT III: Rubber, palmyrah and oil palm

UNIT IV: Coconut and arecanut

UNIT V: Wattle and betel vine

Practical

Description of botanical and varietal features, selection of mother palms and seedlings in coconut and arecanut, soil test crop response studies and manuring practices, pruning and training, maturity standards, harvesting, Project preparation for establishing plantations, Visit to plantations.

Suggested Readings

Anonymous, 1985. *Rubber and its Cultivation*. The Rubber Board of India.

Chopra VL & Peter KV. 2005. *Handbook of Industrial Crops*. Panima.

Harler CR. 1963. *The Culture and Marketing of Tea*. Oxford Univ. Press.

Kurian A & Peter KV. 2007. *Commercial Crops Technology*. New India Publ. Agency.

Nair MK, Bhaskara Rao EVV, Nambiar KKN & Nambiar MC. 1979. *Cashew*. CPCRI, Kasaragod.

Peter KV. 2002. *Plantation Crops*. National Book Trust.

Pradeep Kumar T, Suma B, Jyothibhaskar&Satheesan KN. 2008.*Management of Horticultural Crops*. Part I, II. New India Publ. Agency.

Rai PS &Vidyachandram B. 1981. *Review of Work Done on Cashew*. UAS, Research Series No.6, Bangalore.

Ranganathan V. 1979. *Hand Book of Tea Cultivation*. UPASI, Tea Res. Stn. Cinchona.

Srivastava HC, Vatsaya B & Menon KKG. 1986. *Plantation Crops – Opportunities and Constraints*. Oxford & IBH.

Thampan PK. 1981. *Hand Book of Coconut Palm*. Oxford & IBH.

PSMA 502 Production Technology of Spice Crops 2+1

Objective

To impart basic knowledge about the importance and productiontechnology of spices grown in India.

Theory

Introduction, importance of spice crops-historical accent, present status - national and international, future prospects, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, site selection, layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection

measures and seed planting material and micro-propagation, precision farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of:

UNIT I

Black pepper, cardamom

UNIT II

Clove, cinnamon and nutmeg, allspice

UNIT III

Turmeric, ginger and garlic

UNIT IV

Coriander, fenugreek, cumin, fennel, ajowain, dill, celery

UNIT V

Tamarind, garcinia and vanilla

Practical

Identification of seeds and plants, botanical description of plant; preparation of herbarium, propagation, nursery raising, field layout and method of planting, cultural practices, harvesting, drying, storage, packaging and processing, value addition; short term experiments on spice crops.

Suggested Readings

Agarwal S, Sastry EVD & Sharma RK. 2001. *Seed Spices: Production, Quality, Export*. Pointer Publ.

Arya PS. 2003. *Spice Crops of India*. Kalyani.

Bhattacharjee SK. 2000. *Hand Book of Aromatic Plants*. Pointer Publ.

Bose TK, Mitra SK, Farooqi SK & Sadhu MK (Eds.). 1999. *Tropical Horticulture*. Vol.I. NayaProkash.

Chadha KL &Rethinam P. (Eds.). 1993. *Advances in Horticulture*. Vols. IX-X. *Plantation Crops and Spices*. Malhotra Publ. House.

cosmos,dianthus, snap dragon, pansy) and ornamental foliages– Introduction and selection of plants for waterscaping and xeriscaping.

Practical

Description of botanical features– Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production-Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Chadha KL & Choudhury B.1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

Chaudhary RC. 1993. *Introduction to Plant Breeding.* Oxford & IBH.

Singh BD. 1990. *Plant Breeding*. Kalyani.

FLA 502 Production Technology of Cut Flowers 2+1

Objective

To impart basic knowledge about the importance and production technology of cut flowers grown in India.

Theory

UNIT I

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.

UNIT II

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO2 on growth and flowering.

UNIT III

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT IV

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

Crops

Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

Practical

Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental horticulture*. Kalyani.

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.52

Lauria A &Ries VH. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.

Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Reddy S, Janakiram B, Balaji T, Kulkarni S &Misra RL. 2007. *HightechFloriculture.* Indian Society of Ornamental Horticulture, New Delhi.

FLA 503 Production Technology for Loose Flowers 2+1

Objective

To impart basic knowledge about the importance and management of loose flowers grown in India.

Theory

UNIT I

Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shadenets, transplanting techniques

Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.

Practical

Selection of ornamental plants**,** practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.

Nambisan KMP.1992. *Design Elements of Landscape Gardening*. Oxford & IBH.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.

Valsalakumari et al. 2008. *Flowering Trees*. New India Publ. Agency.

Woodrow MG.1999. *Gardening in India.* Biotech Books.

FLA 505 Protected Floriculture 2 + 1

Objective

Understanding the principles, theoretical aspects and developing skills in protected cultivation of flower crops.

Theory

UNIT I

Prospects of protected floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures – economics of cultivation; Location specific designs; Structural components; Suitable flower crops for protected cultivation.

UNIT II

Environment control – management and manipulation of temperature, light, humidity, air and CO2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT III

Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM.

UNIT IV

Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photo period regulation.

UNIT V

Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards.

Practical

Study of various protected structures, practices in design, layout and erection of different types of structures, practices in preparatory operations, soil decontamination techniques, practices in environmental control systems, practices in drip and fertigation techniques, special horticultural practices, determination of harvest indices and harvesting methods, postharvest handling, packing methods, project preparation, visit to commercial greenhouses.

Suggested Readings

PROGRAMME-16

Ph.D.

AGRONOMY

Course Title : Current Trends in Agronomy

Course Code :Agron 601

Credit Hours : 3+0

Aim of the course

To acquaint the students about recent advances in agricultural production.

Theory

Unit I

Agro-physiological basis of variation in yield, recent advances in soil plant-water relationship.

Unit II

Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures and ITK in organic farming.

Unit III

Crop residue management in multiple cropping systems; latest developments in plant management Mechanizationin crop production: modern agricultural precision tools and technologies, weed management, cropping systems, grassland management, agro-forestry, allelopathy.

Unit IV

GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

Unit V

Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

Conservation agriculture, principles, prospects and importance, potential benefits of CA under climate change scenario, policy issues.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Recent advances in agricultural production

Suggested Reading

• Agarwal RL. 1995. Seed Technology. Oxford & IBH.

• Dahiya BS and Rai KN. 1997. Seed Technology. Kalyani.

• Govardhan V. 2000. Remote Sensing and Water Management in Command Areas: AgroecologicalProspectives. IBDC.

• ICAR. 2006. Hand Book of Agriculture. ICAR.

• Narasaiah ML. 2004. World Trade Organization and Agriculture. Sonali Publ.

• Palaniappan SP and Annadurai K. 2006. Organic Farming - Theory and Practice. Scientific Publ.

• Sen S and Ghosh N. 1999. Seed Science and Technology. Kalyani.

• Tarafdar JC, Tripathi KP and Kumar M. 2007. Organic Agriculture Scientific Publ.

• Kumar, R, Swarnkar KS, Singh KS and Narayan S. 2016. A Text Book of Seed Technology. Kalyani Publication.

• Reddy SR and Prabhakara G. 2015. Dryland Agriculture. Kalyani Publishers.

• Gururajan B, Balasubhramanian R and Swaminath V. 2013. Recent Strategies on Crop Production. Kalyani Publishers.

• Venkateswarlu B and ShankerArun K. 2009. Climate change and agriculture: Adaptation and mitigation strategies. Indian Journal of Agronomy 54(2): 226-230.

Course Title : Recent Trends in Crop Growth and Productivity

Course Title :

Course Code :Agron 602

Credit Hours : 2+1

Aim of the course

To study the physiology of vegetative and reproductive growth in relation to productivity of different crops in various environments.

Theory

Unit I

Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

Unit II

Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

Unit III

Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.

Unit IV

Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Practical

• Field measurement of root-shoot relationship in crops at different growth stages

• Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth

• Computation of harvest index of various crops

• Assessment of crop yield on the basis of yield attributing characters

• Construction of crop growth curves based on growth analysis data

• Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping

• Senescence and abscission indices

• Analysis of productivity trend in un-irrigated areas

• Analysis of productivity trend in irrigated areas

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of crop growth for agricultural production

Suggested Reading

• Chopra VL and Paroda RS. 1984. Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants. Oxford & IBH.

• Delvin RM and Vitham FH. 1986. Plant Physiology. CBS Publ.

• Evans LT. 1975. Crop Physiology. Cambridge Univ. Press.

• Evans LT. 1996. Crop Evolution, Adaptation and Yield. Cambridge Univ. Press.

• Gupta US. (Ed.). 1995. Production and Improvement of Crops for Drylands. Oxford & IBH.

• Gupta US. 1988. Progress in Crop Physiology. Oxford & IBH.

• Kramer PJ and Boyer JS. 1995. Water Relations of Plant and Soils. Academic Press.

• Mukherjee S and Ghosh AK. 1996. Plant Physiology. Tata McGraw Hill.

• Narwal SS, Politycka B and Goswami CL. 2007. Plant Physiology: Research Methods. Scientific Pub.

• Tiaz L. and Zeiger E. 2006. Plant Physiology. Sinauer Associates, Inc.

Course Title : Irrigation Management

Course Code :Agron 603

Credit Hours : 2+1

Aim of the course

To teach students about optimization of irrigation in different crops under variable agro climatic conditions.

Theory

Unit I

Global water resources; Water resources of India, irrigation projects during pre and post independence period and their significance in crop production; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

Unit II

Movement of water in soil-water movement under saturated and unsaturated conditions, Poiseulle's and Darcy's law, general equation of saturated and unsaturated flow of water in soil.

Soil-plant-water relationships, evaporation, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity

Unit III

Water requirement, irrigation needs, factors affecting irrigation need; water use efficiency, Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

Unit IV

Soil and plant water potential, SPAC, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, factors affecting ET, control of ET by mulching and use of anti-transpirents; fertilizer use in relation to irrigation.

Unit V

Crop water stress – water deficits and crop growth, adoptability to the crops. Water availability with relation to nutrient availability.

Unit VI

Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

Unit VII

Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

Unit VIII

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Unit IX

Economic analysis of irrigation and cop planning for optimum use of irrigation water

Unit X

Crop water production function

Practical

• Determination of water infiltration characteristics and water holding capacity of soil profiles.

• Determination Moisture extraction pattern of crops

• Determination of water balance component of transplanted rice by drum culture technique

• Determination of consumptive use and water requirement of a given cropping pattern

• Determination of crop efficient of one important crop

• Planning, designing and installation of drip irrigation system

• Planning, designing and installation of sprinkler irrigation system

• Designing of drainage channel

• Measurement of irrigation efficiencies

• Determination of irrigation timing under different methods of irrigation

• Visit to irrigation command area

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Management of irrigation water for sustainable agriculture

Suggested Reading

• MP. Singh 2017. Recent advances in Irrigation water management. Kalyani Publishers

• FAO. 1984. Irrigation Practice and Water Management. Oxford & IBH.

• Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.

• Mishra RR and Ahmad M. 1987. Manual on Irrigation and Agronomy. Oxford & IBH.

• Panda SC. 2003. Principles and Practices of Water Management. Agrobios.

• Determination of co-efficient of utilization;
• Qualitative and quantitative profile of bio-molecules: practicing analytical techniques for analysis of free amino acids of haemolymph;
• Zymogram analyses of amylase;
• Determination of chitin in insect cuticle;
• Examination and count of insect haemocytes.

Learning outcome

• The scholars are expected to have thorough theoretical and practical knowledge of insect physiology that can be made use of in practical/ applied entomological aspects.
• Understand how physiological systems in insects are integrated to maintain homeostasis.

Suggested Reading

Ananthkrishnan TN. (Ed.). 1994. Functional Dynamics of Phytophagous Insects. Oxford and IBH, New Delhi.
Bernays EA and Chapman RF. 1994. Host-Plant Selection by Phytophagous Insects. Chapman and Hall, London. Kerkut GA and Gilbert LI. 1985. Insect Physiology, Biochemistry and Pharmacology. Vols. IXIII. Pergamon Press, Oxford, New York.
Muraleedharan K. 1997. Recent Advances in Insect Endocrinology. Association for Advancement of Entomology, Trivandrum, Kerala.
Rockstein, M. 1978. Biochemistry of Insects, Academic Press. Simpson, SJ. 2007. Advances in Insect Physiology, Vol. 33, Academic Press (Elsevier), London, UK.

Course Title : Insect Ecology and Diversity
Course Code : ENT 603
Credit Hours : 3 (2+1)
Aim of the course

To impart advanced practical knowledge of causal factors governing the distribution and abundance of insects and the evolution of ecological characteristics. Study insect-plant interactions; get acquainted with biodiversity and conservation.

Theory
Unit I

Characterization of distribution of insects- Indices of Dispersion, Taylor's Power law. Island Biogeography. Population dynamics- Life tables, Leslie Matrix, Stable age distribution, Population projections. Predator-Prey Models- Lotka-Volterra and Nicholson-Bailey Model. Crop Modeling- an introduction.

Unit II

Insect Plant Interactions. Fig-figwasp mutualism and a quantitative view of types of associations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Meaning of stress- plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses. Host seeking behavior of parasitoids.

Unit III

Biodiversity and Conservation- RET species, Ecological Indicators. Principles of Population genetics, Hardy Weinberg Law, Computation of Allelic and Phenotypic frequencies, Fitness under selection, Rates of Evolution under selection. Foraging Ecology- Optimal foraging theory, Marginal Value Theorem, and Patch departure rules, central place foraging, Mean-variance relationship and foraging by pollinators, Nutritional Ecology.

Unit IV

Reproductive ecology- Sexual selection, Mating systems, Reproductive strategies – timing, egg number, reproductive effort, sibling rivalry and parent-offspring conflict. Agro-ecological vs Natural Ecosystems – Characterisation, Pest Control as applied ecology- case studies.

Practical

• Methods of data collection under field conditions;

• Assessment of distribution parameters, Taylor's power law, Iwao's patchiness index, Index of Dispersion, etc.;

• Calculation of sample sizes by different methods;

• Fitting Poisson and Negative Binomial distributions and working out the data transformation methods;

• Hardy-Weinberg Law, Computation of Allelic and Phenotypic Frequencies – Calculation of changes under selection, Demonstration of genetic drift;
• Assessment of Patch Departure rules. Assessment of Resource size by female insects using a suitable insect model, fruit flies/ Goniozus/ Female Bruchids, etc.;
• A test of reproductive effort and fitness;
• Construction of Life tables and application of Leslie Matrix – population projections, Stable age distribution;
• Exercises in development of Algorithms for crop modeling;

Learning outcome

• The scholar is expected to develop expertise in methods of data collection for insect population studies, data transformation for analyses, diversity estimates, assessing distribution parameters, study the impact of abiotic and biotic factors on the distribution and abundance of insects.
• Should gain significant knowledge on construction of life tables and their analyses, assessment of resource size by female insects, reproductive effort and fitness.

Suggested Reading

Barbosa P and Letourneau DK. (Eds.). 1988. Novel Aspects of Insect-Plant Interactions. Wiley, London. Elizabeth BA and Chapman RF. 1994. Host-Plant Selection by Phytophagous Insects. Chapman and Hall, New York. Freeman S and Herron JC.1998. Evolutionary Analysis. Prentice Hall, New Delhi. Gotelli NJ and Ellison AM. 2004. A Primer of Ecological Statistics. Sinauer Associates, Sunderland, MA. Gotelli NJ. 2001. A Primer of Ecology. 3rd Ed., Sinauer Associates, Sunderland, MA, USA. Krebs C. 1998. Ecological Methodology. 2nd Ed. Benjamin-Cummings Publ. Co., New York. Krebs CJ. 2001 Ecology: The Experimental Analysis of Distribution and Abundance. 5th Ed. Benjamin-Cummings Publ. Co., New York. Magurran AE. 1988. Ecological Diversity and its Measurement. Princeton University Press, Princeton. Real LA and Brown JH. (Eds.). 1991. Foundations of Ecology: Classic Papers with Commentaries. University of Chicago Press, USA. Southwood TRE and Henderson PA. 2000. Ecological Methods. 3rd Ed. Wiley Blackwell, London. Strong DR, Lawton JH and Southwood R. 1984. Insects on Plants: Community Patterns and Mechanism. Harward University Press, Harward. Wratten SD and Fry GLA. 1980. Field and Laboratory Exercises in Ecology. Arnold Publ., London.

Course Title : Bio-inputs for Pest Management
Course Code : ENT 605
Credit Hours : 3 (2+1)
Aim of the course
To appraise the students with advanced techniques in handling of different bioagents, modern methods of biological control and scope in cropping system-based pest management in agro-ecosystems.
Theory
Unit I
Scope of classical biological control and augmentative bio-control; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of bio-agents vis-à-vis target pest populations.
Unit II
Bio-inputs: mass production of bio-pesticides, mass culturing techniques of bioagents, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.
Unit III
Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of bio-control agents, bankable project preparation.
Unit IV
Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in bio-control agents for introgressing and for progeny selections, breeding techniques of bio-control agents.
Practical
• Mass rearing and release of some commonly occurring indigenous natural enemies;
• Assessment of role of natural enemies in reducing pest populations;
• Testing side effects of pesticides on natural enemies;
• Effect of semio-chemicals on natural enemies, breeding of various bio-control agents, performance of efficiency analyses on target pests;
• Project document preparation for establishing a viable mass-production unit/ insectary;
• Observation of feeding behavior acts of predatory bugs/ beetles.

Learning outcome

• Scholars are expected to learn the mass multiplication techniques of the more common and economically feasible natural enemies to be exploited under IPM programmes.

• They should be able to guide entrepreneurs for establishing a viable massproduction unit/ insectary.

Suggested Reading

Burges HD and Hussey NW. (Eds.). 1971. Microbial Control of Insects and Mites. Academic Press, London. Coppel HC and James WM. 1977. Biological Insect Pest Suppression. Springer Verlag, Berlin. De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman and Hall, London. Dhaliwal, GS and Koul O. 2007. Biopesticides and Pest Management. Kalyani Publishers, New Delhi. Gerson H and Smiley RL. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman and Hall, New York. Huffakar CB and Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London. Restructured and Revised Syllabi of Post-graduate Programmes Vol. 1 206

Course Title : Insecticide Toxicology and Residues

Course Code : ENT 606

Credit Hours : 3 (2+1)

Aim of the course

To acquaint the students with the latest advancements in the field of insecticide toxicology, biochemical and physiological target sites of insecticides, and pesticide resistance mechanisms in insects.

Theory

Unit I

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides. Modes of action of newer insecticide molecules; developments in bio-rational approaches; SPLAT; RNAi technology for pest management.

Unit II

Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism of insecticides.

Unit III

Joint action of insecticides; activation, synergism and potentiation.

Unit IV

Problems associated with pesticide use in agriculture: pesticide resistance; resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.

Unit V

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; bound and conjugated residues, effect on soil fertility; insecticide laws and standards, and good agricultural practices.

Practical

• Residue sampling, extraction, clean-up and estimation of insecticide residues by various methods;

• Calculations and interpretation of data;

• Biochemical and biological techniques for detection of insecticide resistance in insects;

• Preparation of EC formulation using neem oil.

VII. Learning outcome

• Scholars are expected to be well versed with the latest technologies of bioassays, insecticide/ pesticide residue analysis and solving problems associated with insect resistance to insecticides.

VIII. Suggested Reading

Busvine JR. 1971. A Critical Review on the Techniques for Testing Insecticides. CABI, London. Dhaliwal GS and Koul O. 2007. Biopesticides and Pest Management. Kalyani Publishers, New Delhi. Hayes WJ and Laws ER. 1991. Handbook of Pesticide Toxicology. Academic Press, New York. Plant Protection–Entomology 207 Ishaaya I and Degheele (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi. Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York. O' Brien RD. 1974. Insecticides Action and Metabolism. Academic Press, New York. Perry AS, Yamamoto I, Ishaaya I and Perry R. 1998. Insecticides in Agriculture and Environment. Narosa Publ. House, New Delhi. Prakash A and Rao J. 1997. Botanical Pesticides in Agriculture. Lewis Publ., New York.

Course Title : Plant Resistance to Insects
Course Code : ENT 607

Credit Hours : 2 (1+1)

Aim of the course

To familiarize the students with recent advances in resistance of plants to insects and acquaint with the techniques for assessment and evaluation of resistance in crop plants.

Theory

Unit I

Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species – gene pool; insect sources – behaviour in relation to host plant factors.

Unit II

Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors.

Unit III

Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; markeraided selection in resistance breeding.

Unit IV

Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

Practical

• Understanding mechanisms of resistance for orientation, feeding, oviposition, etc., allelochemical bases of insect resistance; • Macroculturing of test insects like aphids, leaf/ plant hoppers, mites and stored grain pests; • Field screening-microplot techniques, infester row technique, spreader row technique and plant nurseries; • Determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.

Learning outcome

• Scholars are expected to identify sources of resistance in different crops and varieties; their utilization in resistance breeding programmes involving screening techniques for specific pests.

Suggested Reading

Panda N. 1979. Principles of Host Plant Resistance to Insects. Allenheld, Osum and Co., New York.
Rosenthal GA and Janzen DH. (Eds.). 1979. Herbivores – their Interactions with Secondary Plant Metabolites. Vol. I, II. Academic Press, New York. Sadasivam S and Thayumanavan B. 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker, New York. Smith CM, Khan ZR and Pathak MD. 1994. Techniques for Evaluating Insect Resistance in Crop Plants. CRC Press, Boca Raton, Florida.

Course Title : Integrated Pest Management

Course Code : ENT 610

Credit Hours : 2 (2+0)

Aim of the course

To acquaint the students with recent concepts of integrated pest management; surveillance and data base management; successful national and international case histories of integrated pest management, non-conventional tools in pest management.

Theory

Unit I

Principles of sampling and surveillance, database management and computer programming; simulation techniques, system analysis and modeling.

Unit II

Study of case histories of national and international programmes, their implementation, adoption and criticism; global trade and risk of invasive pests; updating knowledge on insect outbreaks and their management.

Unit III

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management-

case studies; scope and limitations of bio-intensive and ecological based IPM programmes; application of IPM to farmers' real time situation.

Unit IV

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

Learning outcome

• Having gained sufficient experience in advanced studies of IPM the scholars should be able to independently frame IPM schedules for major crops/ cropping ecosystems (cereal/ pulse crop/ oilseed crop based/ vegetable crop based agro-ecosystems).

Suggested Reading

Dhaliwal GS and Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publishers, New Delhi. Dhaliwal GS, Singh R and Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publishers, New Delhi. Flint MC and Bosch RV. 1981. Introduction to Integrated Pest Management. Springer, Berlin. Koul O and Cuperus GW. 2007. Ecologically Based Integrated Pest Management. CABI, London. Koul O, Dhaliwal GS and Curperus GW. 2004. Integrated Pest Management –Potential, Constraints and Challenges. CABI, London. Maredia KM, Dakouo D and Mota-Sanchez D. 2003. Integrated Pest Management in the Global Arena. CABI, London. Metcalf RL and Luckman WH. 1982. Introduction to Insect Pest Management. John Wiley and Sons, New York. Norris RF, Caswell-Chen EP and Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi. Pedigo RL. 1996. Entomology and Pest Management. Prentice Hall, New Delhi. Subramanyam B and Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York

– The scholars should develop critical skills in conducting systematic and objective research by using robust methods while minimising biases and errors – The students should intelligently choose and apply advanced methods and tools at every stage of research and execute them in a objective way by managing the actors and processes effectively – The students should develop expertise in designing tests, scales and indexes along with other tools to measure the socio-psychological processes at individual, group and community levels

Suggested Reading

Berg B. 2009. Qualitative Research. Methods for the Social Sciences. Boston: Allyn& Bacon. Creswell JW .2007. Qualitative inquiry and research design: Choosing among five approaches (2nd ed.). Thousand Oaks, CA: SAGE Pub. Edwards AL. 1957. Techniques of attitude scale construction. East Norwalk, CT, US: AppletonCentury-Crofts. Furr, RM. 2011. Scale construction and psychometrics for social and personality psychology. Los Angeles: SAGE Pub. Malhotra, NK. 2010. Marketing research: An applied orientation. Sixth Edition. Upper Saddle River, NJ: Prentice Hall Pub. Netemeyer RG, Bearden WO and Sharma S. 2003. Scaling procedures: issues and applications. Thousand Oaks: SAGE Publications. Nunnally, JC, and Bernstein IH. 1994. Psychometric theory (3rd ed.). New York, NY: McGrawHill Rao, C.R. and Sinharay S. 2007. Handbook of Statistics, Vol. 26: Psychometrics, The Netherlands; Elsevier Science B.V. Raykov T and Marcoulides GA. 2010. Introduction to Psychometric Theory. New York, NY: Taylor & Francis Scott J and Carrington PJ. 2011. The SAGE handbook of social network analysis. London: SAGE. Sekaran U and Bougie R. 2013. Research Methods for Business A Skill-Building Approach. 6th Edition, Wiley, New York. Sivakumar PS, Sontakki BS, Sulaiman RV, Saravanan R and Mittal N. (eds). 2017. Good Practices in Agricultural extension Research. Manual on Good Practices in Extension Research and Evaluation. Agricultural Extension in South Asia. Centre for research on innovation and science and policy (CRISP), Hyderabad. India. http://www.aesanetwork.org/ wp-content/uploads/2018/07/6.pdf

Course Title : Technology Commercialisation and Incubation

Course Code : EXT 603

Credit Hours : 2+1

Why this course?

The technology commercialisation and incubation is an emerging area which links technology development, transfer and commercialisation processes with entrepreneurship development. Technology commercialisation aims to realize the value of agricultural technologies developed at the research establishments, by maximising their utility to stakeholders. With the increasing awareness of protecting and commercialising the Intellectual Property Resources (IPR) in the free market economy, there is a need to understand the organic relationship between protection and commercialisation IPR, and entrepreneurship development.

Aim of the course

This course is aimed to develop a critical understanding among extension students about how the technology commercialisation process is linked to IPR management and entrepreneurship development.

The course is organized as follows:

No	**Blocks**	**Units**
1.	Technology commercialisation and Commercialisation the modern context	1. Basics of Technology 2. Nature of Agricultural Technology 3. Basics of Technology Transfer and Commercialisation
2.	Intellectual Property Resources (IPR) Management	1. Overview of Intellectual Property Resources 2. Systems for protecting IP 3. Management of IPR 4. Protection and Management of Biological Resources 5. Protection, Management and Commercialisation of Grass root and

	Farmers Innovations, Traditional and Indigenous Knowledge 6. Geographical Indications (GI) and Appellation of Origin 7. Genetically Modified Organisms (GMO), Agriculture and Biosafety
3. Technology commercialisation	1. Technology Assessment and Refinement 2. Technology Valuation 3. Technology Commercialisation Strategies 4. Scaling up of Technologies 5. Technology Licensing 6. Technology Takers and Entrepreneurship 7. Policy Support for Technology Commercialisation and Entrepreneurship Development
4. Technology Incubation	1. Basics of Technology Incubation 2. Technology Incubation in India
5. Technology promotion and essential skills for technology commercialisation	1. Technology Promotion 2. Dealing with Entrepreneurs, Agripreneurscommercialisation and Other Stakeholders
6. Emerging approaches in technology commercialisation and incubation	1. Technology Scouting

Theory

Block 1: Technology Commercialisation and the Modern Context

Unit 1: Basics of technology commercialisation

Technology - Definition, functions, process of technological advancement – invention, discovery, innovation and technology; types of innovation - Basic research, Breakthrough innovation, Disruptive Innovation and Sustaining Innovation; Technology transfer and commercialisation

Unit 2: Nature of Agricultural Technology

Agricultural technology – meaning, types; technology generation system; technology life cycle

Unit 3: Basics of Technology transfer and commercialisation

Technology transfer Vs Commercialisation; Technology commercialisation process – elements, models, systems and processes; Technology transfer model – research, disclosure, development and commercialisation

Block 2: Intellectual Property Resources (Ipr) Management

Unit 1: Overview of Intellectual Property Resources

Introduction to IPR; Overview & Importance; Genesis; IPR in India and IPR abroad; Patents, copyrights, trademarks & trade secrets, geographical indication, industrial design; Emergence of IPR Regimes and Governance Frameworks - Trade-Related Aspects of Intellectual Property Rights (TRIPS), Convention on Biological Diversity (CBD), Cartagena Protocol, International Union for Protection of New Plant Varieties (UPOV), and BIMSTEC.

Unit 2: Systems for Protecting IP

IPR protection laws and systems – National IPR Policy; and IPR laws; procedures for filing IP protection; Systems of IP protection and management in agricultural universities and research institutions and also by stakeholders

Unit 3: Management of IPR

Mechanisms of IPR Management – Institutional arrangement, IP Management processes – invention disclosure; IP portfolio management; Infringement management

Unit 4: Protection and Management of Biological Resources

Introduction; National Biodiversity Act (2002); Protection of Plant Varieties and Farmers Rights Act (2001); Guidelines for registration and transfer of biological resources; Farmers rights; Mechanisms of documenting/ collecting, protecting and commercialising farmers varieties and other biological resources; National Biodiversity Authority, PPVFRA and other agencies involved in management of biological resources in India. Access to Genetic Resources and Sharing of Benefits

Unit 5: Protection, Management and Commercialisation of Grassrootand Farmers Innovations, Traditional and Indigenous Knowledge

Traditional and Indigenous Knowledge, Grassroot and Farmers Innovations – Meaning, forms and importance; Systems of documentation, registration, protection and commercialisation. Documentation of traditional indigenous knowledge - Traditional Knowledge Digital Library (TKDL), Community Biodiversity Registers (CBRs), People's Biodiversity Registers (PBRs), Plant Biodiversity Register, and Honeybee Network.

Unit 6: Geographical Indications (GI) and Appellation of Origin

Geographical indications and appellation of origin – meaning, origin; Geographical Indications of Goods (Registration and Protection) Act (1999); Documentation, registration and commercialisation of GI protected materials and processes.

Unit 7: Genetically Modified Organisms (GMO), Agriculture and Biosafety

The Global Concerns on Use of Genetically Modified Organisms in Food and Agriculture; The Cartagena Protocol on Bio-safety; Regulation of GMO in India - Recombinant DNA Advisory Committee (RDAC), Institutional Bio-safety Committee (IBSC), Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Approval Committee (GEAC), State Bio-safety Coordination Committee (SBCC) and District Level Committee (DLC). Laws and Acts for regulation of GMO - Guidelines for Research in Transgenic Plants, 1998; Seed Policy, 2002; Plant Quarantine Order, 2003; Regulation for Import of GM Products Under Foreign Trade Policy, 2006; National Environment Policy, 2006

Block 3: Technology Commercialisation

Unit 1: Technology Assessment and Refinement

Meaning; Importance; Approaches and methods of assessment and refinement of various technologies – stakeholder oriented approaches including participatory technology assessment and refinement; assessment and refinement of traditional and indigenous knowledge and grassroot innovations

Unit 2: Technology Valuation

Returns to investment; IP Valuation-Oxford context, IP Valuation methods - Cost approach; Income approach - Discounted Cash Flow, Risk-Adjusted Net Present Value, Net Present Value with Monte Carlo Simulation and Real Options Theory; Market approach - Industry Standards Method, Rating/Ranking Method, Rules of Thumb Approach and Auction Method; Hybrid approaches; Royalty rate method

Unit 3: Technology Commercialisation Strategies

Meaning- approaches for technology commercialisation – technology scaling up, technology licensing, handholding, agripreneur development, technology business incubation

Unit 4: Scaling up of Technologies

Meaning, types and stages of technology scaling up; mechanisms

Unit 5: Technology Licensing

Meaning and types - Procedures of licensing, preparing licensing documents; Management of technology licensing process

Unit 6: Technology Takers and Entrepreneurship

Meaning; types of technology takers; Technology Taking as a Strategy; Types of entrepreneurship – agripreneurs, startups, small businesses, Producer Organizations, Self Help Groups, Clusters and other forms of entrepreneurship

Unit 7: Policy support for Technology Commercialisation and Entrepreneurship

Development Policy support for entrepreneurship development in India - National Policy on Skill Development and Entrepreneurship and other polices;

Government of India Support for Innovation and Entrepreneurship – Startup India, Make in India, Digital India, Atal Innovation Mission and others; Entrepreneurship policy and schemes at different states of India; Organisations promoting entrepreneurship in India

Block 4: Technology Incubation

Unit 1: Basics of Technology Incubation

Meaning, functions and types; stakeholder oriented incubation process – Livelihood incubation, village incubators

Unit 2: Technology Incubation in India

System of technology incubation- incubation process; its effectiveness; Managing profit oriented and non-profit incubators; Schemes for promoting incubators in India

Block 5: Technology Promotion And Essential Skills For Technology Commercialisation

Unit 1: Technology Promotion

Technology promotion – meaning, types, business meetings, scientist-industry/ entrepreneur meets, technology conclave, business plan competition, farmers fairs, technology shows

Unit 2: Dealing with Entrepreneurs, Agripreneurs and Other Stakeholders

Business communication; Business Etiquette; business networking

Block 6: Emerging Approaches in Technology Commercialisation and Incubation

Unit 1: Technology Scouting

Technology Scouting and Innovations in technology incubation

Practicals

• Understanding the technology commercialisation process – Visit to Technology Commercialisation Unit of ICAR Institute/ Agricultural University • Understanding the IPR protection practices – Visit to Patent Attorney office • Hands-on experience in drafting IPR application – Patent/Copyright/

Trademark • Understanding protection of biological resources including plant varieties – Visit to PPVFRA Branch office/ ICAR Institute or Agricultural University involved in plant variety protection • Documenting Traditional and indigenous knowledge – Field experience in using various protocols of using traditional and indigenous knowledge • Protecting unique local goods through Geographical Indications – Hands on experiences in documenting and registering Geographical indications • Technology assessment/ validation of traditional and indigenous knowledge – QuIK and other methods • Hands on experience in technology valuation • Hands on experience in technology licensing process including drafting agreements • Understanding the Technology Business Incubation – Visit to Agri Business Incubator or Technology Business incubator • Hands on experience in planning and organising technology promotion events • Hands on experience in various techniques in business communication and Business etiquette

Teaching methods/activities

– Lecture cum discussion – Cases – Class exercises – Assignment (Reading/Writing) – Student's Book/Publication Review – Group Presentation

Learning outcome

At the end of the course the students are expected to develop competencies in: – Enabling stakeholders to protect and manage their IPR – Managing IPR to maximise their value realisation through commercialisation, and – Providing mentoring and handholding support to agripreneurs, rural entrepreneurs, start-ups, Farmer Organisations and other forms of entrepreneurs through incubation

Suggested Reading

Bandopadhyay D. 2018. Securing Our Natural Wealth: A Policy Agenda for Sustainable Development in India and for Its Neighbouring Countries. Singapore; Springer. Ghosh, S. and Joshi, A. 2017. Handbook for Non-Profit Incubator Managers. New Delhi: Deutsche GesellschaftfürInternationale. Gupta AK. 2016. Grassroots Innovation: Minds on the margin are not marginal minds. Gurgaon: Penguin Books. ICAR.2018. ICAR Guidelines for Intellectual Property Management and Technology Transfer/ Commercialization (Revised in 2018). Indian Council of Agricultural Research, New Delhi. Pandey N and Dharni K. 2014. Intellectual Property

GENETICS & PLANT BREEDING

Course Title : Advances in Plant Breeding Systems*

Course Code : GPB 601

Credit Hours : 3(3+0)

Why this course?

This course is an advancement of principles, various plant breeding methodologies and procedures in the development of a complex population; MAS for selection of qualitative and quantitative traits, Gene pyramiding, marker-based utilization of exotic Germplasm and introgression libraries.

Aim of the course

To impart theoretical knowledge about advances in plant breeding.

Theory

Unit I

Advances in reproductive biology of crops; Genes governing the whorls formation and various models proposed; Pollen pistil interaction: biochemical and molecular basis, environmental factors governing anthesis and bottlenecks for gene transfer.

Unit II

Plant Breeding methodologies: Classic versus modern; Over view of Pre and Post Mendelian breeding methods in self and cross pollinated crops; Molecular and transgenic breeding approaches; doubled haploid breeding, shuttle breeding, forward and reverse breeding, speed breeding, participatory plant breeding, breeding for organic situations.

Unit III

Principles and procedures in the formation of a complex population; Genetic basis of population improvement in crop plants; Recurrent selection methods

in self and cross pollinated crops and their modifications; Convergent selection, divergent selection; Recurrent selection, usefulness in hybrid breeding programs; Reciprocal recurrent selection; Selection in clonally propagated crops – Assumptions and realities.

Unit IV

Choice of molecular markers for plant breeding efficiency, fingerprinting and genetic diversity assessment, application of MAS for selection of qualitative and quantitative traits; Gene pyramiding, accelerated backcrossing, marker-based utilization of exotic germplasm, introgression libraries.

Unit V

Genetic resources: primary, secondary, tertiary and alien trans gene pool; Molecular and biochemical basis of self-incompatibility and male sterility, nucleocytoplasmic interactions with special reference to male sterility – genetic, biochemical and molecular bases.

Unit VI

Genetic engineering technologies to create male sterility, prospects and problems, use of self-incompatibility and sterility in plant breeding – case studies; Fertility restoration in male sterile lines and restorer diversification programs; Conversion of agronomically ideal genotypes into male sterile: Concepts and breeding strategies; Case studies - Generating new cyto-nuclear interaction system for diversification of male sterile; Stability of male sterile lines – Environmental influence on sterility, Environmentally Induced Genic Male Sterility (EGMS) – Types of EGMS; Influence on their expression, genetic studies; Photo and thermo sensitive genetic male sterility and its use in heterosis breeding; Temperature sensitive genetic male sterility and its use heterosis breeding; Apomixis and its use in heterosis breeding; Incongruity: Factors influencing incongruity Methods to overcome incongruity mechanisms.

Unit VII

Breeding for climate change -Improving root systems, abiotic stress tolerance, water use efficiency, flooding and sub-mergence tolerance; Biotic stress tolerance; Nutrient use efficiency, nitrogen fixation and assimilation, greenhouse gases and carbon sequestration; Breeding for bio-fortification.

Teaching methods

• Power point presentation • Chalk and Board • Smart board • Lectures • Assignments, quiz • Group tasks, student's presentations

Learning outcome

After completion of this course the student will be able to know variousplant breeding methodologies, principles and procedures for the formation of a complex population; MAS for selection of qualitative and quantitative traits, Gene pyramiding, marker based utilization of exotic Germplasm and Breeding for climate change

Suggested Reading

Agarwal RL. 1996. Fundamentals of Plant Breeding and Hybrid Seed Production. Oxford & IBH. Allard RW. 1966. Principles of Plant Breeding. John Wiley & Sons. Briggs FN and Knowles PF. 1967. Introduction to Plant Breeding. Reinhold. Fehr WR. 1987. Principles of Cultivar Development: Theory and Technique. Vol I. Macmillan. Hayes HK, Immer FR and Smith DC. 1955. Methods of Plant Breeding. McGraw-Hill. Kang MS and Priyadarshan PM (Edit.). 2007. Breeding Major Food Staples. Blackwell Publishing. Kole C. 2013. Genomics and Breeding for Climate-Resilient Crops. Springer. Volume 2-Target Traits. Mandal AK, Ganguli PK and Banerji SP. 1995. Advances in Plant Breeding. Vol. I, II. CBS. Richards AJ. 1986. Plant Breeding Systems. George Allen & Unwin. Sharma JR. 1994. Principles and Practice of Plant Breeding. Tata McGraw-Hill. Simmonds NW. 1979. Principles of Crop Improvement. Longman. Singh BD. 1997. Plant Breeding: Principles and Methods. 5th Ed., Kalyani Publishers, New Delhi. Singh P.

1996. Essentials of Plant Breeding. Kalyani Publishers, New Delhi. Welsh JR. 1981. Fundamentals of Plant Genetic and Breeding. John Wiley.

Course Title : Advances in Biometrical Genetics

Course Code : GPB 602

Credit Hours : 3(2+1)

Why this course?

This course is essential to understand various qualitative, quantitative systems/ techniques related to genetic improvement of crops, G x E Interaction, Construction of saturated linkage maps and Marker Assisted Selection (MAS).

Aim of the course

To impart theoretical knowledge and computation methods for non-allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

Unit I

Continuous variation-evolutionary studies; Genetic principles of continuous variation, Qualitative and quantitative techniques-differences, population types, approaches; various types of metrics, F2, FD and mixed; Selection of parents Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes.

Unit II

Components of mean- Additive effect, breeding value, coefficient of gene dispersion, dominance; Simple scaling test, expectation of mean of character in various types of families in coupling and dispersed phase; Epistasis-Specification, weighted and un-weighted joint scaling test; Effect of linkage to generation mean, specification of mean to G × E interaction.

Unit III

Component of variances-advantages, variances of different generations, balance sheet of variance; estimation of parameters-weighted and unweighted, least square analysis; random mating population; experimental population-BIPs, NCD-I, II, III, Triple test cross for random mating population and inbreds; Estimates of linkage and non-allelic interactions; Combining ability analysis, Hayman's Approach.

Unit IV

G × E Interaction, stability and adaptability; Advanced models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) analysis and other related models; Merits and limitation of different stability analysis methods; Analysis and selection of genotypes; Methods and steps to select the best model - Biplots and mapping genotypes.

Unit V

Construction of saturated linkage maps, concept of framework map development; QTLs-different types of markers and mapping populations, linkage maps, mappingStrategies for QTL mapping - desired populations, statistical methods; MAGIC populations, Marker Assisted Selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on markers - simultaneous selection based on marker and phenotype - Factors influencing MAS; Heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods; Use of advanced software packages for biometrical analysis, interpretation of analysed data.

Practical

• Generation mean analysis: ABC scaling test and Joint scaling test- Analysis and interpretation; • Estimation of variance of different filial generations and interpretations; • Diallel analysis: Numerical, graphical and combining ability analysis; Triallel analysis; • NC Designs: Triple test cross analysis; • Stability analysis: Eberhart and Russel model; • AMMI model - Principal Component Analysis model - Additive and multiplicative model - Shifted multiplicative

model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes; • Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; • Phenotype and Marker linkage studies; • Use of advanced software in biometrical analysis.

Teaching methods

• Power point presentation • Chalk and Board • Smart board • Lectures • Assignments, quiz • Group tasks, student's presentations

Learning outcome

After the completion of this course student will be able to understand various Qualitative and quantitative techniques, G x E Interaction, Construction of saturated linkage maps and Marker Assisted Selection, Use of advanced software packages for biometrical analysis, interpretation of analysed data.

Suggested Reading

Bos I and Caligari P. 1995. Selection Methods in Plant Breeding. Chapman & Hall. Dabholkar AR.1993. Elements of Biometrical Genetics. Concept Publishing Co. New Delhi. Falconer DS and Mackay J. 1996. Introduction to Quantitative Genetics (4 Ed.). ELBS/ Longman, London. Mather K and Jinks JL. 1985. Biometrical Genetics (3rd Ed.). Chapman and Hall, London. Nandarajan N and Gunasekaran M. 2008. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi. Roy D. 2000. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi. Singh P and Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi. Singh RK and Choudhary BD. 1987. Biometrical Methods in Quantitative Genetics. Kalyani Publishers, New Delhi. Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates. Wricke G and Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter.

Course Title : Molecular Cytogenetics for Crop Improvement

Course Code : GPB 603

Credit Hours : 2(2+0)

Why this course?

This course is needed to understand organization and structure of genome, karyotyping, Pre-breeding and applications of cytogenetically methods for crop improvement

Aim of the course

This course focuses on applications of cytogenetic techniques for crop improvement.

Theory

Unit I

Organization and structure of genome, Genome size, Organization of organellar genomes, Nuclear DNA organization, Nuclear and Cytoplasmic genome interactions and signal transduction; Inheritance and expression of organellar DNA; Variation in DNA content - C value paradox; Sequence complexity – Introns and Exons, Repetitive sequences, Role of repetitive sequence.

Unit II

Karyotyping – Chromosome banding and chromosome painting; Tracking introgressions using FISH, GISH, localization and mapping of genes/ genomic segments.

Unit III

Pre-breeding and applications of cytogenetical methods for crop improvement; Location and mapping of genes on chromosomes: deficiency method; Interchange genetic consequence, identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; Multiple interchanges-use in producing inbreds, transfer of genes- linked marker

methods; Duplication - production and use; Inversions and location of genes; B A chromosome translocations and gene location.

Unit IV

Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics methods of production, breeding behavior and location of genes; Intervarietal substitutions-allelic and nonallelic interactions; Telocentric method of mapping.

Unit V

Cytogenomics: Concept, tools and techniques for crop improvement; Chromosome sorting: Isolation of specific chromosome for development of molecular maps and gene location.

Unit VI

Role of polyploidy in crop evolution and breeding. Auto- and allopolyploids; Distant hybridization, barriers to interspecific and intergeneric hybridization; Behaviour of interspecific and intergeneric crosses.

Teaching methods

• Power point presentation • Chalk and Board • Smart board • Lectures • Assignments, quiz • Group tasks, student's presentations

Learning Outcome

After the completion of this course the student will be able to understand Organization and structure of genome, karyotyping, Pre-breeding, polyploidy and applications of cytogenetically methods for crop improvement.

Suggested Reading

Clark MS and Wall WJ. 1996. Chromosomes: The Complex Code. Chapman & Hall. 30 June 1996 Conger BV. (Ed.). 1981. Cloning Agricultural Plants via in-vitro Techniques. CRC Press. 31 January 2018 Constabel F and Vasil IK. (Eds.). 1988. Cell Culture and Somatic Cell Genetics of Plants. Vol. V. Cell Culture and Phytochemicals in Plant Cell Cultures. Academic Press. Gupta P K. 2006. Cytogenetics. Rastogi Publisher Lal R and Lal S. (Eds.). 1990. Crop Improvement Utilizing Biotechnology. CRC Press. Mantel SH and Smith H. 1983. Plant Biotechnology. Cambridge University Press. Sen SK and Giles KL. (Eds.). 1983. Plant Cell Culture in Crop Improvement. Plenum Press. 13 July 2013 Yao-Shan F. 2002. Molecular Cytogenetics: Protocols and Application. Human Press

Course Title : Plant Genetic Resources, Conservation and Utilization

Course Code : GPB 604

Credit Hours : 2(2+0)

Why this course?

This course is needed to make the student aware about the importance of Plant Genetic Resources its Conservation and Utilization in crop improvement.

Aim of the course

To impart knowledge on the methods of germplasm conservation and its utilization

Theory

Unit I

Concept of natural reserves and natural gene banks; In situ conservation of wild species in nature reserves: in situ conservation components, factors influencing conservation value, national plan for in situ conservation; in situ conservation of agro-biodiversity on-farm; scientific basis of in situ conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of in situ conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

Unit II

Ex situ conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, perma-frost conservation, guidelines for seed multiplication and exchange to network of active/ working collections, orthodox, recalcitrant seeds- differences in handling, clonal repositories, genetic stability under long term storage condition.

Unit III

In-vitro storage, maintenance of in-vitro culture under different conditions, in-vitro bank maintenance for temperate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/ suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems, prospects of in-vitro gene bank.

Unit IV

Cryopreservation- procedure for handling seeds of orthodox and recalcitrant-cryoprotectants, desiccation, rapid freezing, slow freezing, vitrification techniques, encapsulation/ dehydration techniques, national facilities, achievements, application of cryopreservation in agricultural, horticultural and forestry crops. Problems and prospects; challenges ahead.

Unit V

Concept and procedure for PGR management, germplasm characterization, evaluation and utilization; Concept of core and mini core; collections and registration of plant germplasm.

Teaching methods

• Power point presentation • Chalk and Board • Smart board • Lectures • Assignments, quiz • Group tasks, student's presentations.

Learning outcome

After the completion of this course the student will be able to know about the various techniques of conservation of Plant Genetic Resources and its Utilization in crop improvement.

Suggested Reading

Ellis RH, Roberts EH and White Head J. 1980. A New More Economic and Accurate Approach to Monitor the Viability of Accessions During Storage in Seed Banks. FAO/ IBPGR Pl. Genet. Resources News 41-3-18. Frankel OH and Hawkes JG. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press, Cambridge. Paroda RS and Arora RK.1991. Plant Genetic resource Conservation and management, NBPGR, New-Delhi. Simmonds NW. 1979. Principles of Crop Improvement, Longman. Westwood MN. 1986. Operation Manual for National Clonal Germplasm Repository. Processed Report. USDA-ARS and Oregon State Univ. Oregon, USA. Withers LA. 1980. Tissue Culture Storage for Genetic Conservation. IBPGR Tech. Rep. IBPGR, Rome, Italy.

Course Title : Genomics in Plant Breeding*

Course Code : GPB 605

Credit Hours : 3(3+0)

Why this course?

The knowledge of recent trends in plant genomics, genome sequencing, molecular maps, and concepts of high-throughput proteomics, metabolomics and phenomics is essential in rapid crop improvement programmes.

Aim of the course

To impart practical skills in advanced molecular techniques in genome mapping structural/ functional genomics.

Theory

Unit I

Introduction to the plant genomes: nuclear, chloroplast and mitochondrial genomes; Concept of genome size and complexity: C-value paradox, repetitive and unique DNA.

Unit II

Genome sequencing: Principles and techniques of conventional approaches and next generation sequencing including sequencing-by-synthesis/ ligation and single molecule real time (SMRT) technologies; Applications of sequence information: structural, functional and comparative genomics; Plant genome projects: Strategies for genome sequencing including shot gun and clone-by-clone method.

Unit III

Molecular maps: Use of molecular markers/ SNPs for development of genetic and physical maps; Linkage and LD-based gene mapping approaches including gene/ QTL mapping, genome wide association studies (GWAS) and association analysis; Integration of genetic and physical map for map-based cloning of economically important genes. Concept of allele mining; Diversity array technology: concepts and applications.

Unit IV

Functional genomics: concept of reverse and forward genetics; Use of activation tagging, transposon tagging, insertional mutagenesis, TILLING and ecoTILLING for crop improvement; Genome-wide and gene-specific transcriptomics approaches: serial analysis of gene expression, massively parallel signature sequencing, next generation sequencing, microarray, northern hybridization, RT-PCR, qRT-PCR and molecular beacon.

Unit V

Development and management of database; Applications of bioinformatics tools/ software in genomics for crop improvement. Basic concepts of high-throughput proteomics, metabolomics and phenomics.

Unit VI

Recent transgene free genome editing tools such as CRISPR-Cas9 system, TALENS and ZFNs for crop improvement. Cisgenesis and Intragenesis tools as twin sisters for Crop Improvement; Genomics-based plant breeding: Genome-Wide Genetic Diversity Studies, Identification of molecular markers linked to single Genes and QTL, Marker Assisted Selection (Marker Assisted Backcross Selection, Association mapping, Breeding by Design, Genome selection).

Teaching methods

• Power point presentation • Chalk and Board

• Smart board • Lectures • Assignments, quiz • Group tasks, student's presentations

Learning outcome

After the completion ofthis course, the student will have expertise on about different techniques for genome sequencing, molecular maps, and concepts of high-throughput proteomics, metabolomics and phenomics in crop improvement

Suggested Reading

Alonso JM, Stepanova AN. 2015. Plant Functional Genomics: Methods and Protocols. Springer. Chopra VL, Sharma RP, Bhat SR and Prasanna BM. 2007. Search for New Genes. Academic Foundation, New Delhi. Hackett PB, Fuchs

PLANT PATHOLOGY

Course Title : Advances in Mycology

Course Code : PL PATH 601

Credit Hours : 2+1

Aim of the course

To acquaint with the advances in mycology

Theory

Unit I

General introduction, historical development and advances in mycology. Recent taxonomic criteria, morphological criteria for classification. Serological, chemical (chemotaxonomy), molecular and numerical (computer based assessment) taxonomy. Interaction between groups: Phylogeny, Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti.

Unit II

Population biology, pathogenic variability/ vegetative compatibility. Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. Biodegradation.

Unit III

Ultra structures and chemical constituents of fungal cells, functions of cell organelles. Mitosis, meiosis, gene action and regulation. Effects of fungal interaction with host plants and other microorganisms; parasitism, symbiosis and commensalism.

Unit IV

Genetic Improvement of Fungal strains. Fungal biotechnology. Fungi mediated synthesis of nano particles – characterization process and application. Mycotoxins problems and its management.

Practical

• Isolation, purification and identification of cultures, spores and mating type determination; • Study of conidiogenesis-Phialides, porospores, arthospores; • Study of fruiting bodies in Ascomycotina; • Identification of fungi up to species level; • Study of hyphal anastomosis; • Morphology of representative plant pathogenic genera form different groups of fungi; • Molecular characterization of fungi.

Suggested Reading

Alexopoulos CJ, Mims CW and Blackwell M. 1996. Introductory Mycology. John Wiley & Sons, New York. Dube HC. 2005. An Introduction to Fungi. 3rd Ed. Vikas Publ. House, New Delhi. Kirk PM, Cannon PF, David JC and Stalpers JA. (Eds.). 2001. Ainsworth and Bisby's Dictionary of Fungi. 9th Ed., CABI, Wallington. Maheshwari R. 2016. Fungi: Experimental Methods in Biology 2nd edn. CRC Press, US. Ulloa M and Hanlin RT. 2000. Illustrated Dictionary of Mycology. APS, St. Paul, Minnesota. Webster J and Weber R. 2007. Introduction to Fungi. Cambridge University Press, Cambridge.

Course Title : Advances in Plant Virology

Course Code : PL PATH 602

Credit Hours : 2+1

Aim of the course

To educate about the advanced techniques and new developments in plant virology.

Theory

Unit I

Origin, evolution and interrelationship with animal viruses. Virus morphology, structure, architecture, replication (overview of host and viral components required), assembly and virus specific cytological effects in infected plant cells. Mechanisms leading to the evolution of new viruses/ strains: mutation, recombination, pseudorecombination, component re-assortment, etc.

Unit II

Major vector groups of plant viruses and their taxonomy, virus-vector relationship, molecular mechanism of virus transmission by vectors. Terminologies used in immunology and serology. Classification, structure and functions of various domains of Immunoglobulins. Production of Polyclonal and monoclonal antibodies for detection of viruses. Immuno/ serological assays (Slide agglutination tests, Test tube precipitation test, Double agar diffusion test, ELISA (DAC, DAS, TAS), Dot Immuno Binding Assay, and nucleic acid based assays for detection of plant viruses.

Unit III

Polymerase Chain Reaction based (PCR, reverse transcriptase PCR, multiplex PCR, Nested PCR, Real time/ q PCR) and non PCR based: LAMP, Fluorescent in situ hybridization (FISH), dot blot hybridization. Plant virus genome organization (General properties of plant viral genome- information content, coding and noncoding regions), replication, transcription and translational strategies of pararetroviruses, geminiviruses, tobamo-, poty-, bromo, cucumo, ilar, tospoviruses, satellite viruses and satellite RNA.

Unit IV

Gene expression, regulation and viral promoters.Genetic engineering with plant viruses, viral suppressors, RNAi dynamics and resistant genes. Virus potential as vectors, genetically engineered resistance, transgenic plants. Techniques and application of tissue culture for production of virus free planting materials. Phylogenetic grouping system based on partial/ complete sequences of virus genomes and using of next generation sequencing technology in plant virus discovery.

Practical

• Purification of viruses, SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation; • Acquaintance with different serological techniques (i) DAC-ELISA (ii) DAS-ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA. Nucleic acid isolation, DOT-blot, southern hybridization, probe preparation,and autoradiography; • PCR application and viral genome cloning of PCR products, plasmid purification, enzyme digestion, sequencing, annotation of genes, analysis of viral sequences (use of gene bank, blast of viral sequences and phylogeny); • Bioinformatics analysis tools for virology (ORF finder, Gene mark, Gene ontology, BLAST, Clustal X/W, Tm pred and Phylogeny programs).

Suggested Reading

Davies 1997. Molecular Plant Virology: Replication and Gene Expression. CRC Press, Florida. Fauquet et al. 2005. Virus Taxonomy. VIII Report of ICTV. Academic Press, New York. Gibbs A and Harrison B. 1976. Plant Virology – The Principles. Edward Arnold, London. Jones P, Jones PG and Sutton JM. 1997. Plant Molecular Biology: Essential Techniques. John Wiley & Sons, New York. Khan J A and Dijkstra. 2002. Plant Viruses as Molecular Pathogens. Howarth Press, New York. Maramorosch K, Murphy FA and Shatkin AJ. 1996. Advances in Virus Research. Vol. 46. Academic Press, New

York. Pirone TP and Shaw JG. 1990. Viral Genes and Plant Pathogenesis. Springer Verlag, New York. Roger Hull. 2002. Mathew's Plant Virology (4th Ed.). Academic Press, New York. Thresh JM. 2006. Advances in Virus Research. Academic Press, New York.

Course Title : Advances in Plant Pathogenic Prokaryotes

Course Code : PL PATH 603

Credit Hours : 2+1

Aim of the course

To learn about the latest developments in all the plant pathogenic prokaryotes as a whole.

Theory

Unit I

Prokaryotic cell: Molecular basis for origin and evolution of prokaryotic life, RNA world, prokaryotic cytoskeletal proteins. Flagella structure, assembly and regulation. Structure and composition (bacteria) cell wall/ envelop, Types of secretion systems (TI to TIV) and their molecular interaction, fimbriae and pili (Type IV pili), Bacterial chromosomes and plasmids, other cell organelles. Growth, nutrition and metabolism in prokaryotes (Embden-Meyerhof-Parmas (EMP) pathway, Phosphoketolase Pathway and EntnerDoudoroff Pathway).

Unit II

Current trends in taxonomy and identification of phyto pathogenic prokarya: International code of nomenclature, Polyphasic approach, New/ special detection methods for identification of bacterial plant pathogens. Taxonomic ranks hierarchy; Identification, Advances in classification and nomenclature.

Unit III

Bacterial genetics: General mechanism of variability (mutation), specialized mechanisms of variability. Transposable genetic elements in bacteria-integron and prophages, Mechanism of gene transfer. Pathogenicity islands, horizontal gene transfer, Bacterial Pan-Genome.

Unit IV

Bacteriophages: Composition, structure and infection. Classification and use of phages in plant pathology/ bacteriology. Host pathogen interactions: Molecular mechanism of pathogenesis: Pathogenicity factors of soft rot, necrosis, wilt, canker, etc. Immunization, induced resistance/ Systemic Acquired Resistance,

Quorum sensing. Bacterial pathogenicity and virulence: Molecular mechanism of virulence and pathogenesis, bacterial secretion systems, pathogenicity of bacterial enzymes that degrade the cell walls, Role of hrp/ hrc genes and TALE effectors. Synthesis and regulation of EPSs.

Unit V

Beneficial Prokaryotes-Endophytes, PGPR, Phylloplane bacteria and their role in disease management. Endosymbionts for host defence. Advances in management of diseases caused by prokaryotes: genetic engineering, RNA silencing; CRISPR cas9.

Practical

• Pathogenic studies and race identification, plasmid profiling of bacteria, fatty acid profiling of bacteria, RFLP profiling of bacteria and variability status, Endospore, Flagella staining, Test for secondary metabolite production, cyanides, EPS, siderophore, specific detection of phytopathogenic bacteria using species/ pathovar specific primers; • Basic techniques in diagnostic kit development, Molecular tools to identify phytoendosymbionts; • Important and emerging diseases and their management strategies.

Suggested Reading

Dale JW and Simon P. 2004. Molecular Genetics of Bacteria. John Wiley & Sons, New York. Garrity GM, Krieg NR and Brenner DJ. 2006. Bergey's Manual of Systematic Bacteriology: The Proteobacteria. Vol. II. Springer Verlag, New York. Gnanamanickam SS. 2006. Plant-Associated Bacteria. Springer Verlag, New York. Mount MS and Lacy GH. 1982. Plant Pathogenic Prokaryotes. Vols. I, II. Academic Press, New York. Sigee DC. 1993. Bacterial Plant Pathology: Cell and Molecular Aspects. Cambridge Univ. Press, Cambridge. Starr MP. 1992. The Prokaryotes. Vols. I–IV. Springer Verlag, New York.

Course Title : Molecular Basis of Host-pathogen Interaction
Course Code : PL PATH 604
Credit Hours : 3 (2+1)
Aim of the course

To understand the concepts of molecular biology and biotechnology in relation to host plant- pathogen interactions.

Theory
Unit I

History of host plant resistance and importance to Agriculture. Importance and role of biotechnological tools in plant pathology. Basic concepts and principles to study host pathogen relationship. Molecular genetics, imaging and analytical chemistry tools for studying plants, microbes, and their interactions.

Unit II

Different forms of plant-microbe interactions and nature of signals/ effectors underpinning these interactions. Plant innate immunity: PAMP/ DAMP. Molecular basis of host-pathogen interaction-fungi, bacteria, viruses and nematodes; recognition system, signal transduction.

Unit III

Induction of defence responses- HR, Programmed cell death, reactive oxygen species, systemic acquired resistance, induced systemic resistance, pathogenesis related proteins, phytoalexins and virus induced gene silencing. Molecular basis of genefor-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes. Gene for gene systems: Background, genetics, phenotypes, molecular mechanisms, races, breakdown of resistance (boom-and-bust cycles), Coevolution-arms race and trench warfare models, Metapopulations, cost of resistance, cost of unnecessary virulence, GFG in agricultural crops vs. natural populations, Durability of resistance, erosion of quantitative resistance.

Unit IV

Pathogen population genetics and durability, viruses vs cellular pathogens.Gene deployment, cultivar mixtures. Disease emergence, host specialization. Circadian clock genes in relation to innate immunity. Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

Practical

• Protein, DNA and RNA isolation, plasmid extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation; • Gene mapping and marker assisted selection; • Development and use of molecular markers in identification and characterization of resistance to plant pathogens and their management.

Suggested Reading

Ministry of Agriculture, Government of India, New Delhi. US National Seed Health System.

e-Resources

http://www.aosca.org/index.htm.
http://www.worldseed.org/enus/international_seed/ishi_vegetable.html
http://www.worldseed.org/en-us/international _seed/ ishi_f.html
http://www.seedtest.org/en/content—1—1132—241.html
http://www.seedhealth.org

Course Title : Plant Biosecurity and Biosafety
Course Code : PATH 606
Credit Hours : 2 (2+0)
Aim of the course

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory
Unit I

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/ resurgence of pests and diseases. Introduction and History of biosecurity and its importance.

Unit II

National Regulatory Mechanism and International Agreements/ Conventions, viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures. World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/ disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

Unit III

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops. Emerging/ resurgence of pests and diseases in the changing scenario of climatic conditions. Issues related to release of genetically modified crops.

Suggested Reading

Biosecurity: A Comprehensive Action Plan. Biosecurity Australia. Biosecurity for Agriculture and Food Production. FAO Biosecurity Toolkit 2008. Grotto Andrew J and Jonathan B Tucker. 2006. Biosecurity Guidance. Khetarpal RK and Kavita Gupta 2006. Plant Biosecurity in India – Status and Strategy. Asian Biotechnology and Development Review 9(2): 3963. Randhawa GJ, Khetarpal RK, Tyagi RK and Dhillon BS (Eds.). 2001. Transgenic Crops and Biosafety Concerns. NBPGR, New Delhi.

e-Resources

http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.sht ml www.fao.org/docrep/010/a1140e/a1140e00.htm Laboratory http://www.who.int/csr/resources/publications/biosafety/WHO_CD S_EPR_2006.pdf http://www.americanprogress.org/kf/biosecurity_ a_comprehensive_ action_plan.pdf www.biosecurity.govt.nz DEFRA. www.defra.gov.uk/animalh/diseases/control/biosecurity/ index.htm www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia Biosecurity New Zealand. http://www.fao.org/biosecurity/ CFIA.

List of Journals

• Annals of Applied Biology – Cambridge University Press, London • Annals of Plant Protection Sciences- Society of Plant Protection, IARI, New Delhi • Annual Review of Phytopathology – Annual Reviews, Palo Alto, California • Annual Review of Plant Pathology – Scientific Publishers, Jodhpur • Canadian Journal of Plant Pathology – Canadian Phytopathological Society, Ottawa • Indian Journal of Biotechnology – National Institute of Science Communication and Information Resources, CSIR, New Delhi • Indian Journal of Mycopathological Research – Indian Society of Mycology, Kolkata. • Indian Journal of Plant Protection – Plant Protection Association of India, NBPGR, Hyderabad. • Indian Journal of Virology – Indian Virological Society, New Delhi • Indian Phytopathology-Indian Phytopathological Society, IARI New Delhi. • Journal of Mycology and Plant Pathology – Society of Mycology and Plant Pathology, Udaipur. • Journal of Plant Disease Science-Association of Plant Pathologists (Central India) PDKV, Akola. • Journal of Phytopathology – Blackwell Verlag, Berlin • Mycologia – New York Botanical Garden, Pennsylvania • Mycological Research – Cambridge University Press, London • Physiological Molecular Plant Pathology – Academic Press, London – Phytopathology – American Phytopathological

SOIL SCIENCE

Course Title : Recent Trends in Soil Physics

Course Code : Soil 601

Credit Hours : 2+0

Aim of the course
To provide knowledge of modern concept sin soil physics.

Theory

Unit I

Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system, soil-plant-atmospheric continuum (SPAC).

Unit II
Fundamentals of fluid flow, Poiseuilles law, Laplace's equation, Darcy's law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated waterflow, capillary conductivity and diffusivity; limitations of Darcy's law; numerical solution for one dimensional waterflow.

Unit III

Theories of horizontal and vertical infiltration under different boundary conditions.

Unit IV

Movement of salts in soils, models formiscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves.

Unit V

Soil air and aeration, mass flow and diffusion processes; thermal properties of soil, heat transfer in soils, differential equation of heatflow, measurement of thermal conductivity of soil; Soil, Plant, Water relations- Plant uptake of soil moisture, Water balance and energy balance in the field; irrigation and water use efficiency.

Unit VI

Soil crust and clod formation; structural management of puddled rice soils; soil conditioning-concept, soils conditioners-types, characteristics, working principles, significance in agriculture.

Unit VII

Solar and terrestrial radiation measurement, dissipation and distribution in soilcrop systems; prediction of evapotranspiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infrared thermometer.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil physical properties and processes in relation to plant growth.

Suggested Reading

• Baver LD, Gardner WH and Gardner WR. 1972. Soil Physics. John Wiley & Sons.
• Hanks and Ascheroft. 1980. Applied Soil Physics. Springer Verlag.
• Hillel D. 1980. Applications of Soil Physics. Academic Press.
• Hillel D. 1980. Environmental Soil Physics. Academic Press.
• Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi.
• Kirkham D and Powers WL. 1972. Advanced Soil Physics. Wiley Interscience.
• Lal R and Shukla MK. 2004. Principles of Soil Physics. Marcel Dekker.
• Oswal MC. 1994. Soil Physics. Oxford & IBH.

Course Title : Modern Concept in Soil Fertility

Course Code : Soil 602

Credit Hours : 2+0

Aim of the course

To provide knowledge of modern concepts of soil fertility and nutrient use in crop production.

Theory

Unit I

Nutrient availability-concept and relationships, modern concepts of nutrient s availability; soil colloids and nutrient availability; soil amendments and availability maintenance of nutrients, soil solution and plant growth; nutrient response functions and availability indices.

Unit II

Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.

Unit III

Chemical equilibria (including solid-solution equilbria) involving nutrientions in soils, particularly in submerged soils; Kinetic studies of nutrients in soils.

Unit IV

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

Unit V

Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.

Unit VI

Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

Unit VII

Carbon– a nutrient central to soil fertility; carbon cycle in nature, stocks, pools and fluxes; greenhouse effect and climate change; carbon sequestration vis-à-vis sustenance of soil quality and crop productivity.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil fertility and fertilizers in relation to plant growth and development.

Suggested Reading

• Barber SA. 1995. Soil Nutrient Bioavailability. John Wiley & Sons.
• Barker V Allen and Pilbeam David J. 2007. Handbook of Plant Nutrition. CRC / Taylor & Francis.
• Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Educ.
• Cooke GW. 1979. The Control of Soil Fertility. Crossby Lockwood & Sons.
• Epstein E. 1987. Mineral Nutrition of Plants - Principles and Perspectives. International Potash Institute, Switzerland.
• Kabata- Pendias Alina 2001. Trace Elements in Soils and Plants. CRC / Taylor & Francis.
• Kannaiyan S, Kumar K and Govindarajan K. 2004. Biofertilizers Technology. Scientific Publ.
• Mortvedt JJ, Shuman LM, Cox FR and Welch RM. (Eds.). 1991. Micronutrients in Agriculture. 2nd Ed. Soil Science Society of America, Madison.
• Prasad R and Power JF. 1997. Soil Fertility Management for Sustainable Agriculture. CRC Press.
• Stevenson FJ and Cole MA. 1999. Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.
• Stevenson FJ. (Ed.). 1982. Nitrogen in Agricultural Soils. Soil Science Society of America, Madison.
• Tisdale SL, Nelson WL, Beaton JD and Havlin JL. 1990. Soil Fertility and Fertilizers. 5th Ed. Macmillan Publ.
• Wild A. (Ed.). 1988. Russell's Soil Conditions and Plant Growth. 11th Ed. Longman.

Course Title : Physical Chemistry of Soil

Course Code : Soil 603

Credit Hours : 2+0

Aim of the course

To impart knowledge about modern concepts of physical chemistry of soils and clays, with emphasis on understanding the processes involved with practical significance.

Theory

Unit I

Colloidal chemistry of in organic and organic components of soils–their formation, clay organic interaction.

Unit II

Predictive approaches for cation exchange equilibria- thermodynamics, empirical and diffuse double layer theory (DDL)- relationships among different selectivity coefficients; structure and properties of diffuse double layer.

Unit III

Thermodynamics of nutrient transformations in soils; Climate change effects on minerology and surface properties of variable charge; cationic and anionic exchange and their models, molecular interaction.

Unit IV Adsorption/desorption isotherms-Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on in organic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).

Unit V

Common solubility equilibria-carbonates, ironoxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use).

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil chemical behaviour on research for solving field problems.

Suggested Reading

• Bear RE. 1964. Chemistry of the Soil. Oxford & IBH.
• Bolt GH and Bruggenwert MGM. 1978. Soil Chemistry. Elsevier.

• Fried M and Broeshart H. 1967. Soil Plant System in Relation to Inorganic Nutrition. Academic Press.
• Greenland DJ and Hayes MHB. 1981. Chemistry of Soil Processes. John Wiley & Sons.
• Greenland DJ and Hayes MHB. 1978. Chemistry of Soil Constituents. John Wiley & Sons.
• Jurinak JJ. 1978. Chemistry of Aquatic Systems. Department of Soil Science and Biometeorology, Utah State University
• McBride MB. 1994. Environmental Chemistry of Soils. Oxford University Press.
• Sparks DL. 1999. Soil Physical Chemistry. 2nd Ed. CRC Press.
• Sposito G. 1981. The Thermodynamics of Soil Solutions. Oxford University Press.
• Sposito G. 1984. The Surface Chemistry of Soils. Oxford University Press.
• Sposito G. 1989. The Chemistry of Soils. Oxford University Press.
• Stevenson FJ. 1994. Humus Chemistry. 2nd Ed. John Wiley.
• vanOlphan H. 1977. Introduction to Clay Colloid Chemistry. John Wiley & Sons.

Course Title : Soil Genesis and Micromorphology

Course Code : Soil 604

Credit Hours : 2+0

Aim of the course

To impart knowledge about the pedogenic processes in soils and to acquaint with the micro-pedological study of soil profile.

Theory

Unit I

Pedogenic evolution of soils; soil composition and characterization.

Unit II

Weathering and soil formation–factors and pedogenic processes; stability and weathering sequences of minerals.

Unit III

Assessment of soil profile development by mineralogical and chemical analysis.

Unit IV

Micro-pedological features of soils–their structure, fabric analysis, role in genesis and classification.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil micro pedology and soil taxonomy on research for solving field problems.

VIII. Suggested Reading

• Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu. • Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. Soil Genesis and Classification. 4th Ed. Panima Publ. • Dixon JB and Weed SB. 1989. Minerals in Soil Environments. 2nd Ed. Soil Science Society of America, Madison. • Grim RE. 1968. Clay Mineralogy. McGraw Hill. • Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi. • Sehgal J. 2002. Introductory Pedology: Concepts and Applications. New Delhi • Sehgal J. 2002. Pedology - Concepts and Applications. Kalyani. • USDA. 1999. Soil Taxonomy. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington. • Wade FA and Mattox RB. 1960. Elements of Crystallography and Mineralogy. Oxford & IBH.

Course Title : Biochemistry of Soil Organic Matter

Course Code : Soil 605

Credit Hours : 2+0

Aim of the course

To impart knowledge related to chemistry and reactions of organic substances and their significance in soils.

Theory

Unit I

Organic matter in soils and its maintenance Role of organic matter in soil productivity; humus levels in soils; current thinking on the maintenance of organic matter in the soils. Carbon retention and sequestration.

Unit II

Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.

Unit III

Nutrient transformation–N, P, S; tracemetal interaction with humic substances, significance of chelation reactions in soils.

Unit IV

Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clayorganic matter complexes.

Unit V

Humus-pesticide interactions in soil, mechanisms.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil biochemistry on research for solving field problems.

Reading Materials

• Lynch JM, Willey JM. Soil Biotechnology. • Paul EA and Clark FE. Soil Microbiology and Biochemistry • Sherwood LM and Woolverton CJ. Prescott's Microbiology. • Subba Rao NS. Advances In Agricultural Microbiology

Course Title : Soil Resource Management

Course Code : Soil 606

Credit Hours : 3+0

Aim of the course

To impart the students basic holistic knowledge on soil resource and latest developments in its sustainable use.

Unit I

Relevance of soil management to sustainable agriculture; soil as a natural resource for biomass production, filtering, buffering, transportation of solutes,

genereserves, and geogenic source of raw materials; soil as a source and sink of greenhouse gases.

Unit II

Concept of sustainable land management (SLM); spatial variability of soils; soil quality and food security; soil quality indices, conservation agriculture in relation to soil quality; soil resilience and resistance.

Unit III

Types, factors and causes of land degradation and desertification; GLASOD classification; application of GIS and remote sensing in monitoring, diagnosis and mapping land degradation; history, distribution, identification and description of soil erosion problems in India; forms of soil erosion; impact of soil erosion-on-site and off-site effects; strategies for erosion control and conservation; soil conservation in hilly, arid, semiarid, coastal and diaralands. Management of forest, peat and muck soils.

Unit IV

Soil conservation planning; land capability classification; soil conservation in special problem are as such as hilly, arid and semi-arid regions, waterlogged and wetlands; land restoration and conservation techniques–erosion control, reclamation of salt affected soils; mine land reclamation, afforestation, organic products, soil fauna and biodegradation.

Unit V

Watershed management-concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socio-economic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds.

Unit VI

Agro-ecological regions of India; potentials and constraints of soils of different regions; land evaluation and rationalizing land use, decision support system with relation to land management; national and international soil policy considerations.

Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

Learning outcome

Experience on the knowledge of soil resources on research for solving field problems.

VII. Suggested Reading

• Abrol IP and Dhruvanarayana VV. 1990. Technology for Wasteland Development. ICAR, New Delhi. • Andriesse JP. 1988. Nature and Management of Tropical Peat Soils, Soil Resources, FAO Soils Bulletin 59, Management and Conservation Service, Land and Water Development Division, FAO, Rome • Blackwell, Dent D and Young A. 1981. Soil Survey and Land Evaluation. George Allen and Unwin, London. • Burrough A and McDonnell RK. 1998.Principles of Geographical Information System. Oxford University Press. • Dan Binkley D and Fisher R. 2012. Ecology and Management of Forest Soils,4th Edition, Wiley. • FAO. 1996. Land Quality Indicators and their Use in Sustainable Agriculture and Rural Development. FAO Land and Water Bulletin.5. FAO, Rome. • Faroq M and Siddique K. (Ed.). 2015. Conservation Agriculture, Springer Nature, Chennai, India. • FESL. 1993. An International Framework for Evaluating Sustainable Land Management, FAO World Soil Resources Report No. 73, Land Development Division, FAO, Rome. • ISSS. 1994. Management of Land and Water Resources for Sustainable Agriculture and Environment. Diamond Jubilee Symposium Publication, Indian Society of Soil Science, New Delhi. • Lal R, Blum WEH, Valentine C and Stewart BA. (Editors). 1988. Methods for Assessment of Soil Degradation. CRC Press, Boca Raton. • Mulders MA. 1987. Remote Sensing in Soil Science. Elsevier Science Publishers, Amsterdam. • Sehgal J. 2014. A Text Book of Pedology Concepts and Application. Kalyani publishers, New Delhi. • SSSA 1996. Methods for Assessing Soil Quality. SSSA Publication Number 49, Madison, Wisconsin, USA.

Note: For minor courses please refer the concerned department's courses outline.

HORTICULTURE (FRUIT SCIENCE)

Course Title : Innovative Approaches in Fruit Breeding

Course Code : FSC 601

Credit Hours : (3+0)

Why this course ?

Modern day fruit culture witnesses rapid changes in production technologies and market trends.Ever changing environment and consumer preferences warrant constant development and adoption of genetically improved varieties.There is more thrust on novelty and distinctness in view of ever increasing competition with enhanced emphasis on tailor made and trait specific designer varieties and rootstocks. The course is thus designed to integrate updated information on inherent breeding systems and innovative gene manipulation technologies enhancing breeding efficiency.

Aim of the course

To update knowledge on current trends and innovative approaches in fruit breeding. The structural organisation of the course is as under:-

No. Blocks	Units
1 Introduction	Current Trends and Status
2 Genetic Mechanisms	Inheritance Patterns and Breeding Systems
3 Breeding for Specific Traits	Plant Architecture, Stress Tolerance and Fruit Quality
4 Fast-Track Breeding	Transgenics, Markers and Genomics

Theory

Block 1: Introduction

Unit I: Current Trends and Status: Modern trends in fruit breeding –with major emphasis on precocity, low tree volume, suitability for mechanization, health benefits, etc.

Block 2: Genetic Mechanisms

Unit I: Inheritance Patterns and Breeding Systems:

Genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits.

Block 3: Breeding for Specific Traits

Unit I: Plant Architecture, Stress Tolerance and Fruit Quality: Recent advances in crop improvement efforts- wider adaptation, plant architecture, amenability to mechanization, fruit quality attributes, stress tolerance, crop specific traits; use of apomixis, gene introgression and wide hybridization (alien genes).

Block 4: Fast-Track Breeding

Unit I: Transgenics, Markers and Genomics:

Molecular and transgenic approaches in improvement of selected fruit crops; fast track breeding – marker assisted selection and breeding (MAS and MAB), use of genomics and gene editing tehnologies.

Crops

Mango, banana, guava, papaya, Citrus, grapes, pomegranate, litchi, apple, pear, strawberry, kiwifruit, plums, peaches, apricot, cherries, nectarines, nut crops .

Teaching Methods/ Activities

• Class room Lectures • Student Seminars/ Presentations • Field Tours/ Demonstrations • Assignments

Learning outcome

On successful completion of the course, the students are expected to • Develop updated knowledge on current breeding objectives and trends • Equip with information on innovative approaches enhancing breeding efficiency

Suggested Reading

Al-Khayari J, Jain SN and Johnson DV. 2018. Advances in Plant Breeding Strategies. Vol. 3: Fruits. Springer. Badenes S and Byrne DH. 2012. Fruit Breeding. Springer. Hancock JF. 2008. Temperate Fruit Crop Breeding: Germplasm to Genomics. Springer. Kole C and Abbott AG. 2012. Genetics, Genomics and Breeding of Stone fruits. CRC. Kole, C. 2011. Wild Crops Relatives: Genomics and Breeding Resources: Tropical and Subtropical Fruits. Springer-Verlag. Kole C. 2011. Wild Crops Relatives: Genomics and Breeding Resource: Temperate Fruits. Springer -Verlag. Jain SN and Priyadarshan PM. 2009. Breeding Plantation and Tree Crops: Tropical Species; Temperate Species. Springer -Verlag. Janick J and Moore JN, 1996. Fruit Breeding. Vols.I-III. John Wiley & Sons, USA. Orton T. 2019. Methods in Fruit Breeding. Elsevier. Singh SK, Patel VB, Goswami AK, Prakash J and Kumar C. 2019. Breeding of Perennial Horticultural Crops. Biotech Books. Delhi.

Course Title : Modern Trends in Fruit Production

Course Code : FSC 602

Credit Hours : (3+0)

Why this course ?

Recent technological developments in propagation and cultural practices paves the way to grow fruit crops in an intensive and mechanised mode. As such a course has been developed to provide latest knowledge and updated account of modern production systems enhancing overall productivity.

Aim of the course

To keep abreast with latest developments and trends in production technologies of tropical, subtropical and temperate fruits.

The course structure is as follows:-

No. Blocks	**Units**
1 Introduction	General Concepts and Current Scenario
2 Advanced Technologies	Propagation, Planting Systems and Crop Regulation
3 Management Practices	Overcoming Stress and Integrated Approaches

Theory

Block 1: Introduction

Unit I: General Concepts and Current Scenario:

National and International scenario, national problems.

Block 2: Advanced Technologies

Unit I: Propagation, Planting Systems and Crop Regulation: Recent advances in propagation – root stocks, planting systems, High density planting, crop modeling, Precision farming, decision support systems – aspects of crop regulation- physical and chemical regulation.

Block 3: Management Practices

Unit I: Overcoming Stress and Integrated Approaches:

Effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, Physiological disorders, Total quality management (TQM) – Current topics.

Crops

Mango, Banana, Grapes, Citrus, Papaya, Litchi, Guava, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherry, Almond, Walnut, Pecan, Strawberry, Kiwifruit.

Teaching Methods/ Activities

• Class room Lectures • Student Seminars/ Presentations • Field Tours/ Demonstrations • Assignments VIII. Learning outcome After the successful completion of the course, the students would have • Updated knowledge on current trends in fruit production.

Suggested Reading

Bartholomew DP, Paull RE and Rohrbach KG. eds. 2002. The Pineapple: Botany, Production, and Uses. CAB International. Bose TK, Mitra SK and Sanyol D. Eds. 2002. Fruits of India – Tropical and Sub- Tropical. 3rd Ed. Vols. I, II. NayaUdyog, Kolkata, India. Dhillon WS and Bhatt ZA. 2011. Fruit Tree Physiology. Narendra Publishing House, New Delhi. Dhillon WS. 2013. Fruit Production in India. Narendra Publishing House, New Delhi. Gowen S. 1995. Bananas and Plantains. Chapman & Hall Publication, US. Litz RE. ed. 2009. The Mango: Botany, Production and Uses. CAB International. Peter KV. 2016. Innovations in Horticulture. NIPA, New Delhi. Robinson JC and Saúco VG. 2010. Bananas and Plantains (Vol. 19). CAB International. Samson JA. 1980. Tropical Fruits. Longman, USA. Sharma RR and Krishna H. 2014. Fruit Production: Major Fruits. Daya Publishing House, Delhi. Singh S, Shivankar VJ, Srivastava AK and Singh IP. 2004. Advances in Citriculture. Jagmander Book Agency, New Delhi. Stover RH and Simmonds NW. 1991. Bananas.

Learning outcome

After the successful completion of the course, the students would have • Complete understanding of growth dynamics in various fruit crops • Know-how on manipulation of growth and development processes.

Suggested Reading

Bhatnagar P. 2017. Physiology of Growth and Development of Horticultural Crops. Agrobios (India). Buchanan B, Gruiessam W and Jones R. 2002. Biochemistry and Molecular Biology of Plants. John Wiley & Sons, US. Fosket DE. 1994. Plant Growth and Development: A Molecular Approach. Academic Press, USA. Leopold AC and Kriedermann PE. 1985. Plant Growth and Development. 3rd Ed. McGraw-Hill, US. Richard N. Arteca. 1995. Plant Growth Substances – Principles and Applications. Chapman & Hall, USA. Roberts J, Downs S and Parker P. 2002. Plant Growth Development. In: Plants (I. Ridge, Ed.), Oxford University Press. Salisbury FB and Ross CW. 1992. Plant Physiology. 4th Ed. Wadsworth Publication.

Course Title : Abiotic Stress Management in Fruit Crops

Course Code : FSC 606

Credit Hours : (2+1)

Why this course ?

Low soil fertility coupled with unpredictable and unfavourable environments often result in stress conditions. Non-availability of optimum level of inputs and congenial weather necessitates the development of suitable management practices to overcome various abiotic stresses. Hence a course is customized.

Aim of the course

To updates knowledge on recent trends in management of abiotic stresses in fruit crops. The course is organised as follows:

No. Blocks	Units
1 Introduction	Basic Aspects and Principles
2 Stress Impact	Assessment, Physiology and Performance
3 Stress Management	Mitigation Measures and Conservation Practices

Theory

Block 1: Introduction

Unit I: Basic Aspects and Principles:

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.). Pollution – increased level of CO2, industrial wastes, impact of stress in fruit crop production, stress indices, physiological and biochemical factors associated with stress, fruit crops suitable for different stress situations.

Block 2: Stress Impact

Unit I: Assessment, Physiology and Performance:

Crop modeling for stress situations, cropping systems, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity.

Block 3: Stress Management

Unit I: Mitigation Measures and Conservation Practices:

Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers. Rain water harvesting,

increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, stability and sustainability indices.

Practical

• Seed treatment/ hardening practices (2); • Container seedling production (2); • Analysis of soil moisture estimates (FC, ASM, PWP) (1); • Analysis of plant stress factors, RWC, chlorophyll flourosence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate, etc. under varied stress situations (5); • Biological efficiencies, WUE, solar energy conversion and efficiency (2); • Crop growth sustainability indices and economics of stress management (2); • Visit to orchards and watershed locations (2); Restructured and Revised Syllabi of Post-graduate Programmes Vol. 1 316

Teaching Methods/ Activities

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

Learning outcome

On successful completion of the course, the students are expected to generate know-how on • Various types of abiotic stresses and their effects • Physiological processes underlying abiotic stresses • Management and conservation practices to overcome stress

Suggested Reading

Blumm A. 1988. Plant Breeding for Stress Environments. CRC Publication, USA. Christiansen, MN and Lewis CF. 1982. Breeding Plants for Less Favourable Environments. Wiley International Science, USA. Kanayama Y and Kochetor. 2015. Abiotic Stress Biology in Horticultural Plants. Springer. Kramer PJ. 1980. Drought Stress and the Origin of Adaptation. In: Adaptation

Texas 77072, USA, 678p. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume II.Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509p. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume III.Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634p. Rai N and Rai M. 2006. Heterosis breeding in vegetable crops. New India Publ. Agency. Ram HH. 1998. Vegetable breeding: principles and practices. Kalyani Publishers, New Delhi. Simmonds NW. 1978. Principles of crop improvement. Longman. Singh BD. 1983. Plant Breeding. Kalyani Publishers, New Delhi. Singh BD. 1983. Plant breeding. Kalyani Publishers, New Delhi. Singh PK, Dasgupta SK and Tripathi SK. 2004. Hybrid vegetable development. International Book Distributing Co. Swarup V. 1976. Breeding procedure for cross-pollinated vegetable crops. ICAR.

Course Title : Abiotic Stress Management in Vegetable Crops

Course Code : VSC 603

Credit Hours : (2+1)

Why this course ?

Improvement of vegetable crops has traditionally focused on enhancing a plant's ability to resist diseases or insects. That is evidenced by the large number of disease- or insect-resistant cultivars or germplasm released and used. Research on crop resistance or tolerance to abiotic stresses (heat, cold, drought, flood, salt, pH, etc.) has not received much attention. However, that is changing as a result of the research and publicity of global warming. The changing environments pose serious and imminent threats to vegetable production and place unprecedented pressures on the sustainability of vegetable production. The challenges and opportunities coexist for our dynamic and resilient industry. In addition to conserving resources, we should mitigate abiotic stresses and adapt to the warming planet. The student of vegetable science need to know the different methods involved to mitigate the abiotic stress in vegetable crops.

Aim of the course

To update knowledge on the recent research trends in the field of abiotic stress management in vegetables. • To teach management practices to mitigate abiotic stress in vegetable crops The course is constructed given as under:

No.	Block	Unit
1	Abiotic stress management in	I Environmental stress vegetable crops II Mechanism and measurements of tolerance III Soil-plant-water relations IV Techniques of vegetable growing qunder high stress condition V Use of chemicals

Theory

Unit I

Environmental stress—its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress.

Unit II

Mechanism and measurements—tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.

Unit III

Soil-plant-water relations—under different stress conditions in vegetable crops production and their management practices.

Unit IV

Techniques of vegetable growing under water deficit, water logging, salinity and sodicity.

Unit V

Use of chemicals—techniques of vegetable growing under high and low temperature conditions, use of chemicals and antitranspirants in alleviation of different stresses.

Practical

• Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops; • Measurement of tolerance to various stresses in vegetable crops; • Short term experiments on growing vegetable under water deficit, water logging, salinity and sodicity, high and low temperature conditions; • Use of chemicals for alleviation of different stresses.

Teaching Methods/ Activities

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

IX. Learning outcome

After successful completion of this course, the students are expected to: • Acquire the knowledge about effect of different abiotic stresses on vegetables • Methods to mitigate abiotic stress in vegetables

Suggested Reading

Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. Plant genetic resources: horticultural crops. Narosa Publ. House. Dwivedi P and Dwivedi RS. 2005. Physiology of abiotic stress in plants. Agrobios. Janick JJ. 1986. Horticultural science. 4th Ed. WH Freeman and Co. Kaloo G and Singh K. 2001. Emerging scenario in vegetable research and development. Research periodicals and book publ. house. Kaloo G. 1994.Vegetable breeding. Vols. I-III. Vedams eBooks. Lerner HR. (Eds.). 1999. Plant responses to environmental stresses. Marcel Decker. Maloo SR. 2003. Abiotic stresses and crop productivity.Agrotech Publ. Academy. Narendra T. et al. 2012. Improving crops resistance to abiotic stress. Wiley and Sons.US. Peter KV and Pradeep Kumar T. 2008. Genetics and breeding of vegetables. (Revised Ed.). ICAR. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables volume II.Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509p. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables volume III. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634p. Ram HH. 2001. Vegetable breeding. Kalyani. Rao NK. (Eds.). 2016. Abiotic stress physiology of horticultural crops. Springer publication.

Course Title : Seed Certification, Processing and Storage of Vegetable Seeds

Course Code : VSC 604

Credit Hours : (2+1)

Why this course ?

Every farmer should able to access healthy seeds which are genetically pure, with high seed vigour and good germination percentage. Timely availability of good quality seeds at reasonable price ensures good yield and profit to the farmers. The seeds plays a vital role in agriculture and acts as a carrier of the genetic potential of varieties. Quality seed production which follows efficient

AGRON 601 Current Trends in Agronomy 3+0

Objective

To acquaint the students about recent advances in agricultural production.

Theory

UNIT I

Agro-physiological basis of variation in yield, recent advances in soil plant-water relationship.

UNIT II

Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures.

UNIT III

Crop residue management in multiple cropping systems; latest developments in plant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy.

UNIT IV

GIS, GPS and remote sensing for crop management, global warming, GMcrops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

UNIT V

Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

Suggested Readings

Agarwal RL. 1995. *Seed Technology*. Oxford & IBH.

Dahiya BS & Rai KN. 1997. *Seed Technology*. Kalyani.

Govardhan V. 2000. *Remote Sensing and Water Management in ommand Areas: AgroecologicalProspectives*. IBDC.

ICAR. 2006. *Hand Book of Agriculture*. ICAR.

Narasaiah ML. 2004. *World Trade Organization & Agriculture*.Sonali Publ.

Palaniappan SP & Annadurai K. 2006. *Organic Farming - Theory and Practice*. Scientific Publ.

Sen S & Ghosh N. 1999. *Seed Science and Technology*. Kalyani.

Tarafdar JC, Tripathi KP & Mahesh Kumar 2007. *Organic Agriculture*. Scientific Publ.

AGRON 604 Advances in Crop Growth and Productivity 2+1

Objective

To study the physiology of vegetative and reproductive growth in relation to productivity of different crops in various environments.

Theory

UNIT I

Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

UNIT II

Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

UNIT III

Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial

measures; heat unit concept of crop maturity: concept and types of heat units.

UNIT IV

Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Practical

- Field measurement of root-shoot relationship in crops at different growth stages
- Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth
- Computation of harvest index of various crops
- Assessment of crop yield on the basis of yield attributing characters
- Construction of crop growth curves based on growth analysis data
- Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping
- Senescence and abscission indices
- Analysis of productivity trend in un-irrigated areas
- Analysis of productivity trend in irrigated areas

Suggested Readings

Chopra VL & Paroda RS. 1984. *Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants*. Oxford and IBH.

Delvin RM & Vitham FH. 1986. *Plant Physiology*. CBS Publ.

Evans LT. 1975. *Crop Physiology*. Cambridge Univ. Press.

Evans LT. 1996. *Crop Evolution, Adaptation and Yield*. Cambridge Univ. Press.

Gupta US. (Ed.). 1995. *Production and Improvement of Crops for Drylands*. Oxford & IBH.

Gupta US. 1988. *Progress in Crop Physiology*. Oxford and IBH.

Kramer PJ & Boyer JS. 1995. *Water Relations of Plant and Soils.* Academic Press.

Mukherjee S & Ghosh AK. 1996. *Plant Physiology*. Tata McGraw Hill.

Narwal SS, Politycka B & Goswami CL. 2007. *Plant Physiology: Research Methods.* Scientific Publishers.

AGRON 605 IrrigationManagement 2+1

Objective

To teach students about optimization of irrigation in different crops under variable agroclimatic conditions.

Theory

UNIT I

Water resources of India, irrigation projects; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

UNIT II

Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity.

UNIT III

Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

UNIT IV

Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

UNIT V

Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

UNIT VI

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Practical

- Determination of water infiltration characteristics and water holding capacity of soil profiles
- Moisture extraction pattern of crops
- Consumptive use, water requirement of a given cropping pattern for optimum/variable productivity
- Crop planning at the farm and project level
- Agronomic evaluation of irrigation projects, case studies

Suggested Readings

FAO. 1984. *Irrigation Practice and Water Management.* Oxford & IBH.

Michael AM. 1978. *Irrigation: Theory and Practice*.Vikas Publ.

Mishra RR & Ahmad M. 1987. *Manual on Irrigation and Agronomy*. Oxford & IBH.

Panda SC. 2003. *Principles and Practices of Water Management.* Agrobios.

Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.

Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.

AGRON 606 Advances in Weed Management 2+0

Objective

To teach about the changing weed flora, new herbicides, their resistance, toxicity, antidotes and residue management under different cropping systems.

Theory

UNIT I

Crop-weed competition in different cropping situations; changes in weed flora, various causes and affects.

UNIT II

Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

UNIT III

Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants.

UNIT IV

Advances in herbicide application techniques; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides.

UNIT V

Development of transgenic herbicide resistant crops; herbicide development, registration procedures.

UNIT VI

Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides, allelochemical herbicide bioassays.

Suggested Readings

Aldrich RJ & Kramer R.J. 1997. *Principles in Weed Management.* Panama Publ.

Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley-Inter Science.

Gupta OP. 2000. *Weed Management – Principles and Practices.* Agrobios.

Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.

Rao VS. 2007. *Principles of Weed Science*. Oxford & IBH.

Ross MA & CarolaLembi A. 1999. *Applied Weed Science.* 2nd Ed. Prentice Hall.

Subramanian SAM & Kumar R.J. 1997. *All About Weed Control*. Kalyani.

Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

AGRON 607 Integrated Farming Systems for Sustainable Agriculture 2+0

Objective

To apprise about different enterprises suitable for different agroclimatic conditions for sustainable agriculture.

Theory

UNIT I

Farming systems: definition and importance; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises.

UNIT II

Concept of sustainability in farming systems; efficient farming systems; natural resources - identification and management.

UNIT III

Production potential of different components of farming systems; interaction and mechanism of different production factors; stability

indifferent systems through research; eco-physiological approaches to intercropping.

UNIT IV

Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems.

UNIT V

New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

Suggested Readings

Ananthakrishnan TN. (Ed.) 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.

Balasubramanian P & Palaniappan SP 2006. *Principles and Practices of Agronomy*. Agrobios.

Joshi M & Parbhakarasetty TK. 2005. *Sustainability through Organic Farming*. Kalyani.

Lampin N. 1990. *Organic Farming*. Farming Press Books.

Palaniappan SP & Anandurai K. 1999. *Organic Farming - Theory and Practice*. Scientific Publ.

Panda S C. 2004. *Cropping systems and Farming Systems*. Agribios.

Reddy M V. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.

Sharma AK. 2001. *A Hand Book of Organic Farming*. Agrobios.

Singh SP. (Ed) 1994. *Technology for Production of Natural Enemies*. PDBC, Bangalore.

Trivedi RN. 1993. *A Text Book of Environmental Sciences*. Anmol Publ.

Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.

Venkata Rao BV. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*. Publ. 3. Parisaraprajna Parishtana, Bangalore.

AGRON 608 Soil Conservation and Watershed Management 2+1

Objective

To teach about different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

Theory

UNIT I

Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

UNIT II

Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.

UNIT III

Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

UNIT IV

Land use capability classification, alternate land use systems; agro-forestry; ley farming; *jhum* management - basic concepts, socio-ethnic aspects, its layout.

UNIT V

Drainage considerations and agronomic management; rehabilitation of abandoned *jhum*lands and measures to prevent soil erosion.

Practical

- Study of different types of erosion
- Field studies of different soil conservation measures

- Run-off and soil loss measurements
- Laying out run-off plot and deciding treatments
- Identification of different grasses and trees for soil conservation
- Visit to a soil conservation research centre, demonstration and training centre

Suggested Readings

Arakeri HR & Roy D. 1984. *Principles of Soil Conservation and Water Management*. Oxford & IBH.

Dhruvanarayana VV. 1993. *Soil and Water Conservation Research in India*. ICAR.

FAO. 2004. *Soil and Water Conservation in Semi-Arid Areas*. *Soils Bull.,* Paper 57.

Frederick RT, Hobbs J, Arthur D & Roy L. 1999. *Soil and Water Conservation: Productivity and Environment Protection.* 3rd Ed. Prentice Hall.

Gurmel Singh, Venkataraman CG, Sastry B & Joshi P. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Murthy VVN. 1995. *Land and Water Management Engineering.* Kalyani.

Tripathi RP & Singh HP. 1993. *Soil Erosion and Conservation*. Wiley Eastern.

Yellamanda Reddy T & Sankara Reddy GH. 1992. *Principles of Agronomy*. Kalyani.

Note : For minor courses please refer the concerned department's courses outline.

ENT 605 Insect Behaviour 1+1

Objective

To acquaint the students with a thorough understanding of how natural selection has led to various survival strategies manifested as behaviour in insects.

Theory

Unit I

Defining Behaviour- Concept of umwelt, instinct, fixed action patterns, imprinting, complex behaviour, inducted behaviour, learnt behaviour and motivation. History of Ethology development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behaviour- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behaviour and behavioural polymorphism.

Unit II

Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.

Unit III

Reproductive behaviour- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Self organization and insect behaviour.

Unit IV

Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, coevolution of plants and insect pollinators. Behaviour in IPM- Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.

Practical

Quantitative methods in sampling behaviour; training bees to artificial feeders; sensorydaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect(DBM or gram pod borer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees. Evaluation of different types of traps against fruit flies with respect to signals; Use of honeybees/*Helicoverpaarmigera*to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

Suggested Readings

Ananthkrishnan TN. (Ed.). 1994. *Functional Dynamics of Phytophagous Insects*. Oxford & IBH, New Delhi.

Awasthi VB. 2001. *Principles of Insect Behaviour*. Scientific Publ., Jodhpur.

Bernays EA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects*. Chapman & Hall, London.

Brown LB. 1999. *The Experimental Analysis of Insect Behaviour.* Springer, Berlin.

Krebs JR & Davies NB. 1993. *An Introduction to Behavioural Ecology.* 3rd Ed. Chapman & Hall, London.

Manning A & Dawkins MS. 1992. *An Introduction to Animal Behaviour*. Cambridge University Press, USA.

Mathews RW & Mathews JR. 1978. *Insect Behaviour.* A Wiley- Inter Science Publ. John Wiley & Sons, New York.

ENT 606 Recent Trends in Biological Control 1+1

Objective

To appraise the students with advanced techniques in handling of different bioagents, moder nmethods of biological control and scope in cropping system-based pest management in agroecosystems.

Theory

Unit I

Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of biocontrol agents *vis-à-vis* target pest populations.

Unit II

Mass culturing techniques, insectary facilities and equipments, basic standards of insectary,viable mass-production unit, designs, precautions, good insectary practices.

Unit III

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, largescale production of biocontrol agents, bankable project preparation.

Unit IV

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.

Practical

Mass rearing and release of some commonly occurring indigenous natural enemies; assessment of role of natural enemies in reducing pest populations; testing side effects of pesticides on natural enemies; effect of semiochemicals on natural enemies, breeding of various biocontrol agents, performance of efficiency analyses on target pests; project document preparation for establishing a viable mass-production unit /insectary.

Suggested Readings

Burges HD & Hussey NW. (Eds.). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

Coppel HC & James WM. 1977. *Biological Insect Pest Suppression.* Springer Verlag, Berlin.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, London.

Dhaliwal, GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.

Gerson H & Smiley RL.1990. *AcarineBiocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall, New York.

Huffakar CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

ENT 607 Advance Insecticide Toxicology 2+1

Objective

To acquaint the students with the latest advancements in the field of insecticide toxicology, biochemical and physiological target sites of insecticides, and pesticide resistance mechanisms in insects.

Theory

Unit I

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.

Unit II

Biochemical and physiological target sites of insecticides in insects; developments inbiorationals, biopesticides and newer molecules; their modes of action and structural –activity relationships; advances in metabolism of insecticides.

Unit III

Joint action of insecticides; activation, synergism and potentiation.

Unit IV

Problems associated with pesticide use in agriculture: pesticide resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.

Unit V

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; insecticide laws and standards, and good agricultural practices.

Practical

Sampling, extraction, clean-up and estimation of insecticide residues by various methods; calculations and interpretation of data; biochemical and biological techniques for detection of insecticide resistance in insects.

Suggested Readings

Busvine JR. 1971. *A Critical Review on the Techniques for Testing Insecticides.* CABI, London.

Dhaliwal GS & Koul O. 2007. *Biopesticides and Pest Management.* Kalyani Publ., New Delhi.

Hayes WJ & Laws ER. 1991. *Handbook of Pesticide Toxicology.* Academic Press, New York.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.

O' Brien RD. 1974. *Insecticides Action and Metabolism.* Academic Press, New York.

Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House, New Delhi.

Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

ENT 608 Advanced Host Plant Resistance 1+1

Objective

To familiarize the students with recent advances in resistance of plants to insects and acquaint with the techniques for assessment and evaluation of resistance in crop plants.

Theory

Unit I

Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool; insect sources – behaviour in relation to host plant factors.

Practical

Isolation of DNA/RNA; purity determinations; base pair estimation; agarose gelelectrophoresis; restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques.

Suggested Readings

Bhattacharya TK, Kumar P & Sharma A. 2007. *Animal Biotehnology*. 1st Ed., Kalyani Publ., New Delhi.

Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. *Molecular Insect Science.* Plenum Press, New York.

Oakeshott J & Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology*. Springer Verlag.

Rechcigl JE & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests*. Lewis Publ., North Carolina.

Roy U & Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publ., NewDelhi.

Singh BD. 2008. *Biotechnology (Expanding Horizons)*.Kalyani Publ., New Delhi.

Singh P. 2007. *Introductory to Biotechnology*. 2nd Ed. Kalyani Publ., New Delhi.

ENT 612 AdvancedIntegrated Pest Management 2+0

Objective

To acquaint the students with recent concepts of integrated pest management. Surviellance and data base management. Successful national and international case histories of integrated pest management, non conventional tools in pest management.

Theory

Unit I

Principles of sampling and surveillance; database management and computer programming, simulation techniques and system analysis and modeling.

Unit II

Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests.

Unit III

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' real time situations.

Unit IV

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management– Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* Springer, Berlin.

Koul & Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI, London.

Koul O, Dhaliwal GS & Curperus GW. 2004. *Integrated Pest Management-Potential, Constraints and Challenges.* CABI, London.

Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.

Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

GP 603 Genomics in Plant Breeding 2+1

Objective

To impart practical skills in advanced molecular techniques in genome mapping structural/functional genomics and development of transgenic crops.

Theory

UNIT I

Introduction to the plant genome- Plant nuclear genomes and theirmolecular description - The chloroplast and the mitochondrial genomes inplants - Genome size and complexity.

UNIT II

Establishment of plant genome mapping projects Genome mapping and use of molecular markers in plant breeding; Strategies for mapping genes of agronomic traits in plants- Approaches for mapping quantitative trait loci; Map based cloning of plant genes.

UNIT III

Regulation of Plant gene expression - Functional genomics – Expression Analysis using Microarrays – Transposon tagging and Insertional mutagenesis- methods and significance- Diversity Array Technology.

UNIT IV

Genome sequencing in plants–Principles and Techniques; Applications of sequence information in plant genome analyses; Comparative genomics–Genome Comparison Techniques- Classical and advanced approaches.

UNIT V

Detection of Single Nucleotide Polymorphism; TILLING and Eco-TILLING; Role of transcriptomics, proteomics and metabolomics in linking genome and phenome; Importance of understanding the phenotypes for exploiting the outcome of genomic technologies- Knock out mutant studies and high throughput phenotyping.

UNIT VI

Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools in structural and functional genomics.

Practical

Chromosome analysis in major field crops - Fluorescence *in situ* hybridization Comparative genomic hybridization Comparative analysis of plant genomes using molecular markers – Genetic map construction using molecular markers – Mapping major genes using molecular markers – QTL mapping in plants – Comparison across mapping populations – Understanding the need genetic algorithms in QTL mapping – Plant Genome Databases – Computational tools to explore plant genome databases Comparative genomics Comparison of genome sequences using tools of bioinformatics- Advanced genomic technologies: TILLING and Eco-TILLING – DNA Array Technology Linking genome sequences to phenotypes: Tools of transcriptomics, proteomics and metabolomics.

Suggested Readings

Baxevanis AD & Ouellette BFF. 2001. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.* Wiley Interscience.

Brown TA. 2002. *Genomes*. Wiley-LISS.

Caetano-Anolles G & Gresshoff PM. 1998. *DNA Markers: Protocols, Applications and Overviews*. Wiley-VCH.

Cantor CR & Smith CL (2004). *Genomics*. Wiley, New York.

Galas DJ & McCormack SJ. 2002. *Genomic Technologies: Present and Future*. Calster Academic Press.

Lal R & Lal S. (Eds.). 1990. *Crop Improvement Utilizing Biotechnology*. CRC Press.

Mantel SH & Smith H. 1983. *Plant Biotechnology*. Cambridge University Press.

Sen SK & Giles KL. (Eds.). 1983. *Plant Cell Culture in Crop Improvement*. Plenum Press.

GP 605 Advances in Plant Breeding Systems 2+0

Objective

To impart theoretical knowledge and computation methods for non allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

UNIT I

Facts about plant breeding before the discovery of Mendelism; Evolutionary concepts of genetics and plant breeding - Flower development and its importance; genes governing the whorls formation and various models proposed; Mating systems and their exploitation in crop breeding; Types of pollination, mechanisms promoting cross pollination.

UNIT II

Self- incompatability and sterility Types of self incompatability: Homomorphic (sporophytic and gametophytic) and heteromorphic - Breakdown of incompatibility Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self incompatibility; Sterility: male and female sterility Types of male sterility: genic, cytoplasmic and cytoplasmic-genic; Exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots – Case studies and breeding strategies; Nucleocytoplasmic interactions with special reference to male sterility – Genetic , biochemical and molecular bases.

UNIT III

Population formation by hybridization Types of populations Mendelian population, gene pool, composites, synthetics etc.; Principles and procedures in the formation of a complex population; Genetic basis of population improvement.

UNIT IV

Selection in self fertilizing crops; Creation of genetic variability selection methods - Selection methods: mass selection, pureline selection, pedigree method (selection in early generations vs advanced generations); Backcross, polycross and test cross.

UNIT V

Selection in cross fertilizing crops – Polycross and topcross selections, Mass and recurrent selection methods and their modifications – Mass selection: grided mass selection, ear to row selection, modified ear to rowselection; Convergent selection, divergent selection; Recurrent selection:Simple recurrent selection and its modifications (restricted phenotypicselection, selfed progeny selection and full sib recurrent selection), Recurrent selection for general combining ability (GCA), Concepts and utilization - Recurrent selection for specific combining ability (SCA) –usefulness in hybrid breeding programmes - Reciprocal recurrent selection(Half sib reciprocal recurrent selection, Half sib reciprocal recurrent selection with inbred tester and Full sib reciprocal recurrent selection); Selection in clonally propagated crops – Assumptions and realities.

UNIT VI

Genetic engineering technologies to create male sterility; Prospects and problems - Use of self- incompatability and sterility in plant breeding – case studies; Fertility restoration in male sterile lines and restorer diversification programmes, Conversion of agronomically ideal genotypes into male steriles, Concepts and breeding strategies; Case studies -Generating new cytonuclear interaction system for diversification of male steriles, Stability of male sterile lines – Environmental influence on sterility– Environmentally Induced Genic

Male Sterility (EGMS), Types of EGMS; Influence on their expression, genetic studies; Photo and thermosensitive genetic male sterility and its use in heterosis breeding, Temperature sensitive genetic male sterility and its use heterosis breeding, Apomixis and its use in heterosis breeding. Incongruity, Factors influencing incongruity - Methods to overcome incongruity mechanisms.

Suggested Readings

Agarwal RL. 1996. *Fundamentals of Plant Breeding and Hybrid Seed Production*. Oxford & IBH.

Allard RW. 1966. *Principles of Plant Breeding*. John Wiley & Sons.

Briggs FN & Knowles PF. 1967. *Introduction to Plant Breeding*. Reinhold.

Fehr WR. 1987. *Principles of Cultivar Development: Theory and Technique*. Vol I. Macmillan.

Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.

Mandal AK, Ganguli PK & Banerji SP. 1995.*Advances in Plant Breeding*. Vol.I, II.CBS.

Richards AJ. 1986. *Plant Breeding Systems*. George Allen & Unwin.

Sharma JR. 1994. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.

Simmonds NW. 1979. *Principles of Crop Improvement*. Longman.

Singh BD. 1997. *Plant Breeding: Principles and Methods*. 5th Ed., Kalyani.

Singh P. 1996. *Essentials of Plant Breeding*. Kalyani.

Welsh JR. 1981. *Fundamentals of Plant Genetic and Breeding*. John Wiley.

http://www.worldseed.org/en-us/international_seed/ishi_f.html ISTA *Seed Health Testing Methods*. http://www.seedtest.org/en/content---1--1132--241.html

Tunwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi.US National Seed Health System. http://www.seedhealth.org/

PL PATH 606 Plant Biosecurity and Biosafety 2+0

Objective

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory

UNIT I

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

UNIT II

National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

UNIT III

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

Suggested Readings

FAO Biosecurity Toolkit 2008.
www.fao.org/docrep/010/a1140e/a1140e00.htm Laboratory Biosecurity Guidance.
http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2006.pdf

Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: A Comprehensive Action Plan.*
http://www.americanprogress.org/kf/biosecurity_a_comprehensive_action_plan.pdf *Biosecurity Australia.* www.daff.gov.au/ba; www.affa.gov.au/biosecurityaustralia Biosecurity *New Zealand*. www.biosecurity.govt.nz DEFRA.
www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm

Randhawa GJ, Khetarpal RK, Tyagi RK & Dhillon. BS (Eds.). 2001. *Transgenic Crops and Biosafety Concerns.* NBPGR, New Delhi.

Khetarpal RK & Kavita Gupta 2006. *Plant Biosecurity in India - Status andStrategy*. Asian Biotechnology and Development Review 9(2): 39-63.

Biosecurity for Agriculture and Food Production.
http://www.fao.org/biosecurity/ CFIA.
http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.shtml87

Note: For minor courses please refer the concerned department's courses outline.

SOILS 605 Biochemistry of Soil Organic Matter 2+0

Objective

To impart knowledge related to chemistry and reactions of organic substances and their significance in soils.

Theory

UNIT I

Organic matter pools in soil; composition and distribution of organic matter in soil and its functions; environmental significance of humic substances; decomposition of organic residues in soil in relation to organic matter pools.

UNIT II

Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.

UNIT III

Nutrient transformation – N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils.

UNIT IV

Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soilaggregation processes; clay-organic matter complexes.

UNIT V

Humus - pesticide interactions in soil, mechanisms.

Suggested Readings

Beck AJ, Jones KC, Hayes MHB & Mingelgrin U. 1993. Organic *Substances in Soil and Water: Natural Constituents and their* 104 *Influences on Contaminant Behavior*. Royal Society of Chemistry, London.

Gieseking JE. 1975. *Soil Components*. Vol. 1. *Organic Components.* Springer-Verlag.

Kristiansen P, Taji A & Reganold J. 2006. *Organic Agriculture: A Global Perspective.* CSIRO Publ.

Magdoff F & Weil RR 2004. *Soil Organic Matter in Sustainable Agriculture*. CRC Press.

Mercky R & Mulongoy K. 1991. *Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture.* John Wiley & Sons.

Paul EA. 1996. *Soil Microbiology and Biochemistry*. Academic Press.

Stevenson FJ. 1994. *Humus Chemistry – Genesis, Composition and Reactions.* John Wiley & Sons.

SOILS 602 Advances in Soil Fertility 2+0

Objective

To provide knowledge of modern concepts of soil fertility and nutrient use in crop production.

Theory

UNIT I

Modern concepts of nutrient availability; soil solution and plant growth; nutrient response functions and availability indices.

UNIT II

Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.

UNIT III

Chemical equilibria (including solid-solution equilbria) involving nutrientions in soils, particularly in submerged soils.

UNIT IV

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

UNIT V

Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.

UNIT VI

Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity underlong-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

Suggested Readings

Barber SA. 1995. *Soil Nutrient Bioavailability*. John Wiley & Sons.

Barker V Allen & Pilbeam David J. 2007. *Handbook of Plant Nutrition*. CRC / Taylor & Francis.

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Educ.

Cooke GW. 1979. *The Control of Soil Fertility*. Crossby Lockwood & Sons.

Epstein E. 1987. *Mineral Nutrition of Plants - Principles and Perspectives*. International Potash Institute, Switzerland.

Kabata- Pendias Alina 2001. *Trace Elements in Soils and Plants*. CRC/ Taylor & Francis.

Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ.

Mortvedt JJ, Shuman LM, Cox FR & Welch RM. (Eds.). 1991. *Micronutrients in Agriculture.* 2nd Ed. Soil Science Society of America, Madison.

Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.

Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients.*John Wiley & Sons.

Stevenson FJ. (Ed.). 1982. *Nitrogen in Agricultural Soils*. Soil Science Society of America, Madison.

Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1990. *Soil Fertility and Fertilizers.* 5th Ed. Macmillan Publ.

Wild A. (Ed.). 1988. *Russell's Soil Conditions and Plant Growth*. 11th Ed. Longman.

SOIL 606 Land use Planning and Watershed Management 2+0

Objective

To teach the better utilization of land for agricultural purposes, and better management of run-off or surplus/excessive rain-water in the catchment area for agricultural purposes in a watershed.

Theory

UNIT I

Concept and techniques of land use planning; factors governing present land use.

UNIT II

Land evaluation methods and soil-site suitability evaluation for different crops; land capability classification and constraints in application.

UNIT III

Agro-ecological regions/sub-regions of India and their characteristics inrelation to crop production.

UNIT IV

Water harvesting - concept, significance, types, methodology; use of harvested water in agriculture to increase water productivity.

UNIT V

Watershed development/management - concept, objectives, characterization, planning, execution, community participation and evaluation; rehabilitation of watershed; PRA; developing economically and ecologically sustainable agro-forestry systems for watershed; case studies.

Suggested Readings

All India Soil and Land Use Survey Organisation 1970. *Soil Survey Manual*. IARI, New Delhi.

FAO. 1976. *A Framework for Land Evaluation*, Handbook 32. FAO.

Sehgal JL, Mandal DK, Mandal C & Vadivelu S. 1990. *Agro-Ecological Regions of India*. NBSS & LUP, Nagpur.

Soil Survey Staff 1998. *Keys to Soil Taxonomy*. 8th Ed. USDA & NRCS, Washington, DC.

USDA 1974. *A Manual on Conservation of Soil and Water Handbook of Professional Agricultural Workers*. Oxford & IBH.

SOIL505 Soil Erosion and Conservation 2+1

Objective

To enable students to understand various types of soil erosion and measures to be taken for controlling soil erosion to conserve soil and water.

Theory

UNIT I

History, distribution, identification and description of soil erosion problems in India.

UNIT II

Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; Rainfall erosivity - estimation as EI_{30} index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

UNIT III

Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.

UNIT IV

Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.

UNIT V

Soil conservation planning; land capability classification; soil conservationin special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

UNIT VI

Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical

- Determination of different soil erodibility indices - suspension percentage,
- dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio,
- percolation ratio, raindrop erodibility index
- Computation of kinetic energy of falling rain drops
- Computation of rainfall erosivity index (EI_{30}) using rain gauge data
- Visits to a watersheds

Suggested Readings

Biswas TD & Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Society of Soil Science No. 17.

Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Spl Publ. No. 49, Madison, USA.

Gurmal Singh, Venkataramanan C, Sastry G & Joshi BP. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Hudson N. 1995. *Soil Conservation*. Iowa State Univ. Press.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science.* ISSS, New Delhi.

Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

Note: For minor courses please refer the concerned department's courses outline.

Suggested Readings

Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha KL & Pareek OP. (Eds.). 1996. *Advances in Horticulture*. Vol. I. Malhotra Publ. House.

Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.

Gowen S. 1996. *Banana and Plantains*. Chapman & Hall.

Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.

Nijjar GS. (Ed.). 1977. *Fruit Breeding in India*. Oxford & IBH.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

Stover RH & Simmonds NW. 1991. *Bananas*. Longman.

FSC 602 Advances in Production of Fruit Crops 2+1

Objective

To keep abreast with latest developments and trends in production technology of fruit crops.

Theory

National and International scenario in fruit production, Recent advances in propagation - root stock influence, planting systems, High density planting, crop modeling , Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, , Total quality management(TQM) - Current topics.

Crops

UNIT I : Mango and banana

UNIT II: Papaya, grapes and citrus

UNIT III: Guava, sapota, pomegranate and aonla

UNIT IV: Pineapple, avocado, jack fruit and fig

UNIT V: Apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Practical

Survey of existing fruit cropping systems and development of a model cropping system, Estimating nutrient deficiency- estimation of water use efficiency, soil test-crop response correlations, practices in plant growth regulation, studying physiological and biochemical responses, quality analysis.

Suggested Readings

Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits – Horticulture*. Allied Publ.

Bose TK, Mitra SK & Sanyal D. (Eds.). 2001. *Fruits -Tropical and Subtropical*. Naya Udyog.

Bose TK, Mitra SK, Farooqi AA & Sadhu MK. 1999. *Tropical Horticulture.* Vol. I. Naya Prokash.

Chadha KL & Pareek OP. (Eds.). 1996. *Advances in Horticulture*. Vols. IIIV. Malhotra Publishing House.

Chadha KL. 2001. *Handbook of Horticulture*. ICAR.

Nakasone HY & Paull RE. 1998. *Tropical Fruits*. CABI.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

FSC 603 Advances in Growth Regulation of Fruit Crops 2+1

Objective

Appraisal on the advances in growth regulation of fruit crops.

Epstein E. 1972. *Mineral Nutrition of Plants: Principles and Perspectives*. Wiley.

Fosket DE. 1994. *Plant Growth and Development: A Molecular Approach*. Academic Press.

Leoplod AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3rd Ed. McGraw-Hill.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.

Salisbury FB & Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

FSC 507 Post Harvest Technology for Fruit Crops 2+1

Objective

To facilitate deeper understanding on principles and practices of postharvest management of fruit crops.

Theory

UNIT I

Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration.

UNIT II

Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT III

Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storageventilated, refrigerated, MAS, CA storage, physical injuries and disorders.

UNIT IV

Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

UNIT V

Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals, estimation of quality characteristics in stored fruits and vegetables, cold chain management - visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products.

Suggested Readings

Bhutani RC. 2003. *Fruit and Vegetable Preservation*. Biotech Books.

Chadha KL & Pareek OP. (Eds.). 1996. *Advances in Horticulture*. Vol. IV. Malhotra Publ. House.

Haid NF & Salunkhe SK. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ.

Mitra SK. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits*. CABI.

Ranganna S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.

Sudheer KP & Indira V. 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.

Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. *Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.

FSC 605 Biotic and Abiotic Stress Management in Horticultural Crops 2+1

Objective

To update knowledge on the recent research trends in the field of biotic and abiotic stress management in horticultural crops.

Theory

UNIT I

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.).

UNIT II

Pollution - increased level of CO2, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations.

UNIT III

Crop modeling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stress and their impact on crop growth and productivity.

UNIT IV

Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers.

UNIT V

Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

Practical

Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors, RWC, chlorophyll flurosence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and water shed locations.

Suggested Readings

Blumm A. 1988. *Plant Breeding for Stress Environments*. CRC.

Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less Favourable Environments*. Wiley Inter. Science.

Gupta US. 1990. *Physiological Aspects of Dry Farming*.

Hsiao TC. 1973. Plant Responses to Water Stress. *Ann. Rev. Plant Physiology* 24:519-570.

Kramer PJ. 1980. Drought Stress and the Origin of Adaptation. In: *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.

Levitt J. 1972. *Response of Plants to Environmental Stresses*. Academic Press.

Maloo SR. 2003. *Abiotic Stress and Crop Productivity*. Agrotech Publ. Academy.

Mussell H & Staples R. 1979. *Stress Physiology in Crop Plants*. Wiley Inter. Science.

Nickell LG. 1983. *Plant Growth Regulating Chemicals*. CRC.

Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.

Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.

Note : For minor courses please refer the concerned department's courses outline.

VSC 601 Advances in Vegetable Production 2+1

Objective

To keep abreast with latest developments and trends in production technology of vegetable crops.

Theory

Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of:

UNIT I : Tomato, brinjal, chilli, sweet pepper and potato

UNIT II : Cucurbits, cabbage, cauliflower and knol-khol

UNIT III :Bhendi, onion, peas and beans, amaranthus and drumstick

UNIT IV :Carrot, beet root and radish

UNIT V : Sweet potato, tapioca, elephant foot yam and taro

Practical

Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; portrays and ball culture; diagnosis of nutritional and physiological disorders; analysis of physiological factors like anatomy; photosynthesis; light intensity in different cropping situation; assessing nutrient status, use of plant growth regulators; practices in herbicide application; estimating water requirements in relation to crop growth stages, maturity indices; dry land techniques for rainfed vegetable production; production constraints;

analysis of different cropping system in various situation like cold and hot set; vegetable waste recycling management; quality analysis ; marketing survey of the above crops; visit to vegetable and fruit mals and packing houses.

Suggested Readings

Bose TK & Som NG. 1986. *Vegetable Crops of India*. Naya Prokash.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Brewster JL. 1994. *Onions and other Vegetable Alliums*. CABI. FFTC. *Improved Vegetable Production in Asia*. Book Series No. 36.

Ghosh SP, Ramanujam T, Jos JS, Moorthy SN & Nair RG. 1988. *Tuber Crops*. Oxford & IBH.

Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publishing Agency.

Kallo G & Singh K. (Ed.). 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.

Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S & Pallai SV. 1996. *Tropical Tuber Crops, Problems, Prospects and Future Strategies*. Oxford & IBH.

Sin MT & Onwueme IC. 1978. *The Tropical Tuber Crops*. John Wiley & Sons.

Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distr. Co.

Singh PK, Dasgupta SK & Tripathi SK. 2006. *Hybrid Vegetable Development*. International Book Distr. Co.

VSC 602 Advances in Breeding of Vegetable Crops 2+1

Objective

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Dhillon BS, Tyagi RK, Saxena S & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.

Janick JJ. 1986. *Horticultural Science*. 4th Ed. WH Freeman & Co.

Kaloo G & Singh K. 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals and Book Publ. House.

Kaloo G. 1994. *Vegetable Breeding*. Vols. I-III. Vedams eBooks.

Peter KV & Pradeep Kumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised Ed.). ICAR.

Ram HH. 2001. *Vegetable Breeding*. Kalyani.

VSC 603 Protected Cultivation of Vegetable Crops 1+1

Objective

To impart latest knowledge in growing of vegetable crops under protected environmental condition.

Theory

Crops: Tomato, capsicum, cucumber, melons and lettuce

UNIT I

Importance and scope of protected cultivation of vegetable crops; principles used in protected cultivation, energy management, low cost structures; training methods; engineering aspects.

UNIT II

Regulatory structures used in protected structures; types of greenhouse / polyhouse / nethouse, hot beds, cold frames, effect of environmental factors, *viz.* temperature, light, CO2 and humidity on growth of different vegetables, manipulation of CO2, light and temperature for vegetable production, fertigation.

UNIT III

Nursery raising in protected structures like poly-tunnels, types of benches and containers, different media for growing nursery under cover.

UNIT IV

Regulation of flowering and fruiting in vegetable crops, technology for raising tomato, weet pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures.

UNIT V

Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production.

Practical

Study of various types of structures, methods to control temperature, CO2 light, media, training and pruning, maintenance of parental lines and hybrid seed production of vegetables, fertigation and nutrient management, control of insect-pests and disease in greenhouse; economics of protected cultivation, visit to established green/polyhouse/net house/shade house in the region.

Suggested Readings

Anonymous 2003. *Proc. All India Seminars on Potential and Prospects for Protective Cultivation*. Organised by Institute of Engineers, Ahmednagar. Dec.12-13, 2003.

Chandra S & Som V. 2000. *Cultivating Vegetables in Green House. Indian Horticulture* 45: 17-18.

Prasad S & Kumar U. 2005. *Greenhouse Management for Horticultural Crops*. 2nd Ed. Agrobios.

Tiwari GN. 2003. *Green House Technology for Controlled Environment.* Narosa Publ. House.

VSC 604 Biotechnologies in Vegetable Crops 2+1

Objective

To teach advances in biotechnology for improvement of vegetable crops.

Theory

Crops: Tomato, eggplant, hot and sweet pepper, potato, cabbage, cauliflower, tapioca, onion, cucurbits.

seed testing equipment and processing machines; seed treatment methods, seed priming and pelleting; field and seed inspection, practices in rouging, seed storage, isolation distances, biochemical tests, visit to seed testing laboratories and processing plants, mixing and dividing instruments, visit to seed processing unit and warehouse visit and know about sanitation standards.

Suggested Readings

Agrawal PK & Dadlani M. 1992. *Tecniques in Seed Science and Technology*. South Asian Publ.

Singh N, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distr. Co.

Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

Tanwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, GOI, New Delhi.

Rajan S & Baby L Markose 2007. *Propagation of Horticultural Crops.* New India Publ. Agency.

VSC 606 Abiotic Stress Management in Vegetable Crops 2+1

Objective

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

UNIT I

Environmental stress and its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress; root stock, use of wild species, use of antitranspirants.

UNIT II

Mechanism and measurements of tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.

UNIT III

Soil-plant-water relations under different stress conditions in vegetable crops production and their management practices.

UNIT IV

Techniques of vegetable growing under water deficit, water logging, salinity and sodicity.

UNIT V

Techniques of vegetable growing under high and low temperature conditions, use of chemicals in alleviation of different stresses.

Practical

Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops, measurement of tolerance to various stresses in vegetable crops, short term experiments on growing vegetable under water deficit, water-logging, salinity and sodicity, high and low temperature conditions, and use of chemicals for alleviation of different stresses.

Suggested Readings

Dwivedi P & Dwivedi RS. 2005. *Physiology of Abiotic stress in Plants*. Agrobios.

Lerner HR (Ed.). 1999. *Plant Responses to Environmental Stresses*. Marcel Decker.

Maloo SR. 2003. *Abiotic Stresses and Crop Productivity*. Agrotech Publ. Academy.

Note : For minor courses please refer the concerned department's course outline.

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

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

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

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

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1

Objective

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

Practical

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

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

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

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme,

Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.

Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

PGS 506 DISASTER MANAGEMENT 1+0

(e-Course)

Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters - Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: Global warming, Sea level rise, Ozone depletion.

UNIT II

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

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

OFFICE OF THE REGISTRAR
RAJMATA VIJAYARAJE SCINDIA KRISHI VISHWAVIDYALAYA
GWALIOR (M.P.)

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Registrar

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E-mail- registrar@rvskvv.net

No./Reg./Estt. /Noti./ 2024-25/ 936 Dated: 28.06.2024

//NOTIFICATION//

The Acadamic Council of the University in its 63nd Meeting, held on dated 06.06.2024 under agenda item No. 09 has approved that following committee tasked with formulating a comprehensive roadmap and strategic plan for the effective implementation of NEP 2020-

1. Dr. Mridula Billore, DFA	Chairman
2. Dr. N.S. Bhadoriya, DI	Member
3. Dr. S.K. Sharma, DRS	Member
4. Dr. Y.P. Singh, DES	Member
5. Dr. S.S. Tomar, Dean, CoA, Gwalior	Member
6. Dr. R.N. Sharma, Dy. Reg. (Acd)	Member Secretary

This committee shall be made responsible for drafting guidelines to enforce mandatory changes in the academic structure of the University in alignment with the provisions of NEP and as per the directives issued by the Indian Council of Agricultural Research.

By order of the Hon'ble Vice-Chancellor

Registrar

No./Reg./Estt. /Noti./ 2024-25/ 937 Dated: 28.06.2024

Copy for information & necessary action:-

1. Dean Faculty of Agriculture, RVSKVV, Gwalior.
2. Director Instruction & Student Welfare, RVSKVV, Gwalior.
3. Dean, College of Agriculture/Horticulture, Gwalior, Indore, Sehore, Khandwa, Mandsaur.
4. Deputy Registrar (Acd./Estt.), RVSKVV, Gwalior.
5. PS to Hon'ble Vice-Chancellor, RVSKVV, Gwalior.
6. Guard file

Registrar