



Deen Dayal Upadhyaya Gorakhpur University,
Gorakhpur 273009

COURSE CURRICULUM AND SYLLABUS
OF
M. Sc. (Ag.) Horticulture

Nomenclature and Credit hour

(On the recommendations of the members of National Core Group, 19 Broad Subject Matter Area (BSMA), ICAR)

| Nomenclature | Credit hours |
|---------------------------------------|--------------|
| Major Courses | 20 |
| Minor Courses | 08 |
| Supporting Course | 06 |
| Common Courses | 05 |
| Credit Seminar | 01 |
| Research work or Research Methodology | 30 |
| Total | 70 |

Major courses: From the discipline in which a student takes admission.

Minor courses: From the subjects closely related to a student's major subject. It is suggested that the student may choose minor courses as these are related to policy advocacy and aim to build larger understanding of the subject. The final choice of the minor courses should be mandatorily approved by the Student Advisory committee/HOD.

Supporting courses: The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

Common Courses: The following courses (one credit each) will be offered to all students undergoing Master's degree programme:

1. Library and Information Services
2. Technical Writing and Communications Skills
3. Intellectual Property and its Management in Agriculture
4. Basic Concepts in Laboratory Techniques
5. Agricultural Research, Research Ethics and Rural Development Programmes

Some of these courses are already in the form of e-courses/ MOOCs. The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/ she may be permitted to register for other related courses with the prior approval of the Head of Department (HoD)/ Board of Studies (BoS).

Name of Programme: M.Sc. (Ag.) Horticulture

Academic eligibility for admission: - B.Sc. (Ag.)

Curriculum and Syllabus

| Course code | Course Title | Credit |
|---------------------------------------|--|-----------|
| Major Courses | | 20 |
| HORT 501 | Propagation and Nursery Management of Fruit Crops | 3(2+1) |
| HORT 502 | Breeding of Fruit Crops | 3(2+1) |
| HORT 503 | Growth and Development of Vegetable Crops | 3(2+1) |
| HORT 504 | Principles of Vegetable Breeding | 3(2+1) |
| HORT 505 | Ornamental Gardening and Landscaping | 3(2+1) |
| HORT 506 | Production of Plantation Crops | 2(1+1) |
| HORT 507 | Post harvest Management of Horticultural Produce | 3(2+1) |
| Minor Courses | | 08 |
| HORT 508 | Production of Medicinal and Aromatic Crops | 3(2+1) |
| HORT 509 | Organic Vegetable Production | 2(1+1) |
| *AGRON 502 | Principles and Practices of Soil fertility and Nutrient Management | 3(2+1) |
| Supporting Courses | | 06 |
| STAT 502 | Statistical Methods for Applied Sciences | 3(2+1) |
| STAT 511 | Experimental Designs | 3(2+1) |
| Common Courses | | 05 |
| PGS 501 | Library and Information Services | 1(0+1) |
| PGS 502 | Technical Writing and Communications Skills | 1(0+1) |
| PGS 503 | Intellectual Property and its management in Agriculture | 1(1+0) |
| PGS 504 | Basic Concepts in Laboratory Techniques | 1(0+1) |
| PGS 505 | Agricultural Research, Research Ethics and Rural Development Programmes | 1(1+0) |
| Seminar | | 01 |
| HORT 591 | Master's Seminar | 1(0+1) |
| Thesis research/ Special paper | | 30 |
| #HORT 599 | Master's Research (Thesis) Or Special paper (Horticultural Research Methodology) | 30 |
| Total Credit | | 70 |

*Minor course covered by Department of Agronomy

#Satisfactory/ Non-Satisfactory

Semester Wise Course Distribution

| Course code | Course Title | Credit |
|---------------------|---|-----------|
| Semester I | | |
| HORT 501 | Propagation and Nursery Management of Fruit Crops | 3(2+1) |
| HORT 502 | Breeding of Fruit Crops | 3(2+1) |
| HORT 503 | Growth and Development of Vegetable Crops | 3(2+1) |
| HORT 504 | Principles of Vegetable Breeding | 3(2+1) |
| STAT 502 | Statistical Methods for Applied Sciences | 3(2+1) |
| PGS 501 | Library and Information Services | 1(0+1) |
| PGS 502 | Technical Writing and Communications Skills | 1(0+1) |
| | | 17 |
| Semester II | | |
| HORT 505 | Ornamental Gardening and Landscaping | 3(2+1) |
| HORT 506 | Production of Plantation Crops | 2(1+1) |
| HORT 508 | Production of Medicinal and Aromatic Crops | 3(2+1) |
| *AGRON 502 | Principles and Practices of Soil fertility and Nutrient Management | 3(2+1) |
| STAT 511 | Experimental Designs | 3(2+1) |
| PGS 503 | Intellectual Property and its management in Agriculture | 1(1+0) |
| PGS 504 | Basic Concepts in Laboratory Techniques | 1(0+1) |
| | | 16 |
| Semester III | | |
| HORT 507 | Postharvest Management of Horticultural Produce | 3(2+1) |
| HORT 509 | Organic Vegetable Production | 2(1+1) |
| PGS 505 | Agricultural Research, Research Ethics and Rural Development Programmes | 1(1+0) |
| | | 06 |
| Semester IV | | |
| HORT 591 | Master's Seminar | 1(0+1) |
| #HORT 599 | Master's Research | 30 |
| | | 31 |

*Minor course covered by Department of Agronomy

#Satisfactory/ Non-Satisfactory

HORTICULTURE

Syllabus

Course Title: Propagation and Nursery Management in Fruit Crops

Course Code: HORT 501

Credit Hours: 3(2+1)

Theory

Block 1: Introduction

Unit 1: General Concepts and Phenomena: Introduction, understanding cellular basis for propagation, sexual and asexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of fruit crops, dormancy, hormonal regulation of seed germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing.

Block 2: Propagation

Unit I: Conventional Asexual Propagation: Cutting– methods, rooting of soft and hardwood cuttings under mist and hotbeds. Use of PGR in propagation, Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

Budding and grafting – principles and methods, establishment and management of bud wood bank. Stock, scion and inter stock relationship – graft incompatibility, physiology of rootstock and top working.

Unit II: Micro propagation: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques – in-vitro clonal propagation, direct organogenesis, embryogenesis, micro grafting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules.

Block 3: Nursery

Unit I: Management Practices and Regulation: Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, nursery accreditation, import and export of seeds and planting material and quarantine.

Practical

- Hands on practices on rooting of dormant and summer cuttings
- studies in rooting of cutting and graft union
- Hands on practices on various methods of budding and grafting
- Propagation by layering and stooling
- Micro propagation- explant preparation, media preparation, culturing – meristem tip culture, axillary bud culture, micro-grafting, hardening
- Visit to commercial tissue culture laboratories and accredited nurseries

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 Propagation- Principles and Practices. Pearson, USA/ Prentice Hall 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. Micro propagation of Woody Trees and Fruits. Springer.

Jain S and Hoggmann H. 2007. Protocols for Micro propagation of Woody Trees and Fruits. Springer.

Joshi P. 2015. Nursery Management of Fruit Crops in India. NIPA, New Delhi.

Sharma RR. 2014. Propagation of Horticultural Crops. Kalyani Publishers, 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: HORT 502

Credit Hours: 3 (2+1)

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
- Pollen viability and fertility studies
- Hands on practices in hybridization
- Raising and handling of hybrid progenies
- Induction of mutations and polyploidy

- Evaluation of biometrical traits and quality traits
- Screening for resistance against abiotic stresses
- Developing breeding programme for specific traits
- Visit to research stations working on fruit breeding

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.

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: Growth and Development of Vegetable Crops

Course Code: HORT 503

Credit Hours: 3 (2+1)

Theory

Unit I

Introduction and phytohormones—Definition of growth and development; Cellular structures and their functions; Physiology of phyto-hormones functioning/ biosynthesis and mode of action; Growth analysis and its importance in vegetable production.

Unit II

Physiology of dormancy and germination—Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellins, cytokinins and abscissic acid; Application of synthetic PGRs including plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

Unit III

Abiotic factors—Impact of light, temperature, photoperiod, carbon dioxide, oxygen and other gases on growth, development of underground parts, flowering and sex expression in vegetable crops; Apical dominance.

Unit IV

Fruit physiology—Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening.

Unit V

Morphogenesis and tissue culture—Morphogenesis and tissue culture techniques in vegetable crops; Grafting techniques in different vegetable crops.

Practical

- Preparation of plant growth regulator's solutions 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;
- Grafting techniques in tomato, brinjal, cucumber and sweet pepper.

Suggested Reading

Bleasdale JKA. 1984. *Plant physiology in relation to horticulture* (2nd Edition) MacMillan.

Gupta US. Eds. 1978. *Crop physiology*. Oxford and IBH, New Delhi.

Kalloo G. 2017. *Vegetable grafting: Principles and practices*. CAB International

Peter KV and Hazra P. (Eds). 2012. *Hand book of vegetables*. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.

Peter KV. (Eds). 2008. *Basics of horticulture*. New India publication agency, New Delhi.

Rana MK. 2011. *Physio-biochemistry and Biotechnology of Vegetables*. New India Publishing Agency, Pritam Pura, New Delhi.

Course Title: Principles of Vegetable Breeding

Course Code: HORT 504

Credit Hours: 3(2+1)

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.

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.

Peter KV and 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.

Course Title: Ornamental Gardening and Landscaping

Course Code: HORT 505

Credit Hours: 3 (2+1)

Theory

Block 1: Gardens and components

Unit I: Styles and types of gardens: Historical background of gardening, Importance and scope of ornamental gardening, styles and types of gardens, formal and informal style gardens. English, Mughal, Japanese, Persian, Spanish, Italian, French, Hindu and Buddhist gardens.

Unit II: Garden components: Garden components (living and non-living): arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, colour wheels, clock garden, bamboo groves, bonsai; Non -living components like-path, garden gate, fencing, paving and garden features like fountains, garden seating, swings, lanterns, basins, bird baths, sculptures, waterfalls,

bridge, steps, ramps, Lawn -genera and species, establishment and maintenance.

Unit III: Specialized gardens: Specialised gardens such as vertical garden, roof garden, terrace garden, water garden, sunken garden, rock garden, shade garden, temple garden, sacred gardens (with emphasis on nativeplants), Zen garden.

Block 2: Landscape planning

Unit I: Principles and elements of landscaping: Basic drawing skills, use of drawing instruments garden symbols, steps in preparation of garden design, programmes phase, design, phase, etc.

Elements and principles of landscape design. Organization of spaces, visual aspects of plan arrangement- view, vista and axis. Principles of circulation, site analysis and landscape, water requirement, use of recycled water.

Unit II: Landscaping for different situations: Urban landscaping, Landscaping for specific situations such as residential, farm houses, institutions, corporate sector, industries, hospitals, roadsides, traffic islands, Children parks, public parks, xeriscaping, airports, railway station and tracks, river banks and dam sites and IT/ SEZ parks. Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening.

Practical

- Graphic language and symbols in landscaping, study of drawing instruments, viz., 'T' square, set square, drawing board, etc.
- Identification of various types of ornamental plants for different gardens and occasions
- Preparation of land, planning, layout and planting, deviations from landscape principles
- Case study
- Site analysis, interpretation of map of different sites, use of GIS for selection
- Enlargement from blue print. Landscape design layout and drafting on paper as per the scale
- Preparation of garden models for home gardens, farm houses, industrial gardens, institutional gardens, corporate, avenue planting, practices in planning and planting of special types of gardens
- Burlapping, lawn making, planting of edges, hedges, topiary, herbaceous and shrubby borders
- Project preparation on landscaping for different situations, creation of formal and informal gardens
- Visit to parks and botanical gardens

Suggested Reading

Bose TK, Chowdhury B and Sharma SP. 2011. Tropical Garden Plants in Colour. Hort. and Allied Publ.

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

India.

Misra RL and Misra S. 2012. Landscape Gardening. Westville Publ. House, New Delhi, India.

Nambisan KMP. 1992. Design Elements of Landscape Gardening. Oxford & IBH Publ. Co., New Delhi, India.

Randhawa GS and Mukhopadhyay A. 1986. Floriculture in India. Allied Publ.

Sabina GT and Peter KV. 2008. Ornamental Plants for Gardens. New India Publ. Agency, New Delhi, India.

Singh A and Dhaduk BK. 2015. A Colour Handbook: Landscape Gardening. New India Publ. Agency, New Delhi, India.

Course Title: Production of Plantation Crops

Course Code: HORT 506

Credit Hours: 2(1+1)

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 sequestration potential 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, multitier cropping, climate and soil requirements, systems of planting, high density planting, nutritional requirements, water requirements, fertigation, moisture conservation, role of growth regulators, macro and micro nutrients, nutrient deficiency symptoms, physiological disorders, shade regulation, 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 primary processing, grading, packaging, storage and benefit cost analysis of plantation crops.

Crops

Coconut, Arecanut, Oilpalm, Cashew, Coffee, Tea, Cocoa, Rubber, Palmyrah, Betel vine

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.

Suggested Reading

- Afoakwa EO. 2016. *Cocoa Production and Processing Technology*. CRC Press.
- Chopra VL and Peter KV. 2005. *Handbook of Industrial Crops*. Panima.
- 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 rubber 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.
- 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.
- Srivastava HC, Vatsaya and Menon, KKG. 1986. *Plantation Crops – Opportunities and Constraints*. Oxford and IBH.

Course Title: Postharvest Management of Horticultural Produce

Course Code: HORT 507

Credit Hours: 3(2+1)

Theory

Block 1: Postharvest Management of Horticultural Produce

Unit I: History, Importance and scope of Postharvest technology of horticultural produce. Nature and structure of horticultural produce. Pre and Postharvest losses and their causes.

Unit II: Climacteric and non-climacteric fruits. Regulation of ripening by use of chemicals and growth regulators. Control of sprouting, rooting and discoloration in vegetables.

Unit III: Maturity indices for harvest. Harvesting and harvesting tools. Curing Horticultural Sciences– Post-harvest Management in roots and tubers. Prepackage Operation: Precooling, washing, sorting, grading of horticultural perishables for local markets and export. Postharvest handling of spices, plantation crops, medicinal and aromatic plants. Equipments for washing, sizing, grading.

Unit IV: Pre and Postharvest treatments for extending storage life/ vase life. VHT, irradiation treatment, skin coating, degreening, etc. Prepackaging, Packaging techniques for local market and export. Standards and specifications for fresh produce.

Unit V: Postharvest handling system for horticulture crops of regional importance. Principles of transport, modes of transportation, types of vehicles and transit requirements for different horticultural produce. Marketing: Factors influencing marketing of perishable crops, marketing systems and organizations.

Practical

- Study of maturity indices for harvest of fruits, vegetables, spices and plantation crops;
- Protective skin coating with wax emulsion and pre and Postharvest treatment with fungicides, chemicals and growth regulators to extend the shelf life of fruits and vegetables;
- Pre-packaging of perishables;
- Extension of vase life of cut flowers by use of chemicals and growth regulators;
- Control of sprouting of potato and onion by using growth regulators;
- Study of modern harvesting, sorting and grading equipments;
- Study of effect of pre-cooling on shelf-life and quality of fresh fruits, vegetables and flowers;
- Visit to packaging centers;
- Visit to local markets, cooperative organizations, super markets dealing with marketing of Perishables.

Suggested Reading

Bhattacharjee SK and Dee LC. 2005. *Postharvest technology of flowers and ornamental plants*. Pointer publishers, Jaipur.

Chattopadhyay SK. 2007. *Handling, transportation and storage of fruit and vegetables*. Gene- Tech books, New Delhi.

Kader AA. 1992. *Postharvest technology of horticultural crops*. 2nd ed university of California.

Pruthi JS. 2001 (Reprint). *Major spices of India crop management and Postharvest technology*. ICAR, New Delhi

Thompson AK. (Ed.) 2014. *Fruit and Vegetables: Harvesting, Handling and Storage* (Vol. 1 & 2)
Blackwell Publishing Ltd, Oxford, UK. ISBN: 9781118654040.

Course Title : Production of Medicinal and Aromatic Crops

Course Code : HORT 508

Credit Hours : 3 (2+1)

Theory

Block 1: Importance of Medicinal and Aromatic Crops

Unit 1: Classification of medicinal and aromatic crops: Importance of medicinal plants, Importance of aromatic plants, Role in national economy, utility sectors of medicinal and aromatic crops, role of institutions, Medicinal Plant Board and NGO's in research and development of medicinal and aromatic crops.

Unit 2: Medicinal and plant based industry: Indian system of medicine, traditional systems of medicine, tribal medicine, medicinal industry, source of medicinal plants, area, production, export and import of major crops, problems, prospects and challenges, IPR issues.

Unit 3: Aromatic plant based industry: Essential oils, classification, physical and chemical properties and storage of essential oils. Indian perfumery industry, area, production, export and import status of major aromatic crops, history and advancements, problems, prospects and challenges, IPR issues.

Block 2: Production technology of medicinal and aromatic crops

Unit 1: Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in medicinal and aromatic crops.

Unit 2: Propagation and nursery management: Seed, vegetative and micro- propagation methods, nursery techniques and nursery management practices. **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.

Block 3: Harvest and Post harvest management

Unit 1: Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons in medicinal and aromatic crops.

Unit 2: Post harvest management: Post harvest management including primary processing, extraction, grading, packaging and storage, GMP in medicinal and aromatic crops.

Crops

A. Medicinal crops: Senna, periwinkle, medicinal coleus, aswagandha, glory lily, sarpagandha, Dioscorea sp., Aloe vera, Andrographis paniculata, Digitalis, medicinal solanum, isabgol, opium poppy, safedmusli, Stevia rebaudiana, Mucuna pruriens, Piper longum, Plumbago zeylanica

B. Aromatic crops: Palmarosa, lemongrass, citronella, vetiver, mentha, patchouli, sweet flag, jasmine, geranium, artemisia, lavender, Ocimum sp., eucalyptus, sandal

Practical

- Description of botanical and varietal features;
- Nursery techniques;
- Lay out and planting;
- Manuring practices;
- Maturity standards;
- Harvesting;
- Primary processing;
- Extraction of oils;
- Herbarium preparation;
- Project preparation for establishing herbal gardens;
- GAP in medicinal and aromatic crops;
- GMP in medicinal and aromatic crops;

Suggested Reading

- Atal CK and Kapur BM. 1982. Cultivation and Utilization of Medicinal Plants. RRL, CSIR, Jammu.
- Barche S. 2016. Production technology of spices, aromatic, medicinal and plantation crops. New India Publishing Agency, New Delhi.
- Das K. 2013. Essential oils and their applications. New India Publishing Agency, New Delhi
- Farooqi AA and Sriram AH. 2000. Cultivation Practices for Medicinal and Aromatic Crops. Orient Longman Publ.
- Farooqi AA, Khan MM and Vasundhara M. 2001. Production Technology of Medicinal and Aromatic Crops. Natural Remedies Pvt. Ltd.
- Gupta RK. 2010. Medicinal and Aromatic plants. CBS publications. Hota D. 2007. Bio Active Medicinal Plants. Gene Tech Books.
- Jain SK. 2000. Medicinal Plants. National Book Trust.
- Khan IA and Khanum A. 2001. Role of Biotechnology in Medicinal and Aromatic Plants. Vol. IX. Vikaaz Publ.
- Kurian A and Asha Sankar M. 2007. Medicinal Plants. Horticulture Science Series, New India Publ. Agency.
- Panda H. 2002. Medicinal Plants Cultivation and their Uses. Asia Pacific Business Press.
- Panda H. 2005. Aromatic Plants Cultivation, Processing and Uses. Asia Pacific Business Press.
- Ponnuswami et al. 2018. Medicinal Herbs and Herbal Cure. Narendra Publishing House, New Delhi.
- Prajapati SS, Paero H, Sharma AK and Kumar T. 2006. A Hand book of Medicinal Plants. Agro Bios.
- Ramawat KG and Merillon JM. 2003. BioTechnology – Secondary Metabolites. Oxford and IBH.
- Shankar SJ. 2018. Comprehensive post harvest technology of flowers, medicinal and aromatic plants. Narendra Publishing House, New Delhi.
- Skaria PB, Samuel M, Gracy Mathew, Ancy Joseph, Ragina Joseph. 2007. Aromatic Plants. New India Publ. Agency.

Course Title: Organic Vegetable Production

Course Code: HORT 509

Credit Hours: 2(1+1)

Theory

Unit I

Importance and principles—Importance, principles, perspective, concepts and components of organic farming in vegetable crops

Unit II

Organic production of vegetables—Organic production of vegetable crops, viz., Solanaceous, Cucurbitaceous, Cole, root and tuber crops

Unit III

Managing soil fertility—Managing soil fertility, mulching, raising green manure Horticultural Sciences—Vegetable Science crops, weed management in organic farming system; Crop rotation in organic production; Processing and quality control of organic vegetable produce

Unit IV

Composting methods—Indigenous methods of composting, Panchyagavya, Biodynamics preparations and their application; ITKs in organic vegetable farming;

Role of botanicals and bio-control agents in the management of pests and diseases in vegetable crops

Unit V

Certification and export—Techniques of natural vegetable farming, GAP and GMP certification of organic products; Export- opportunity and challenges

Practical

- Methods of preparation and use of compost, vermicompost, biofertilizers and biopesticides;
- Soil solarisation;
- Use of green manures;
- Waste management; Organic soil amendments in organic production of vegetable crops;
- Weed, pest and disease management in organic vegetable production;
- Visit to organic fields and marketing centres.

Suggested Reading

Dahama AK. 2005. *Organic farming for sustainable agriculture*. 2nd Ed. Agrobios.

Gehlot G. 2005. *Organic farming; standards, accreditation certification and inspection*. Agrobios.

Palaniappan SP and Annadorai K. 2003. *Organic farming, theory and practice*. Scientific publ.

Pradeepkumar T, Suma B, Jyothibhaskar and Satheesan KN. 2008. *Management of horticultural crops*. New India Publ. Agency.

Shivashankar K. 1997. *Food security in harmony with nature*. 3rd IFOAMASIA, Scientific Conf. 1- 4 December, UAS, Bangalore.

HORT 591 Seminar**1 (0+1)**

The seminar paper will be related to the area of research of the candidate and the candidate should have to give a seminar presentation of it.

Course Title : Principal and Practices of Soil Fertility and Nutrient Management**Course Code : AGRON 502****Credit Hours : 3(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.

HORT-599 (Special Paper) Research Methodology**UNIT I: Research Methodology at a glance**

Importance and scope of research in Horticulture for agricultural development. Objective of research, Requirement of research, Research planning, Characteristics of a research planning programme, Research problem, Steps for identifying a research problem.

UNIT II: Field Plot Techniques

Principles of experimental design, Important design for field experimentation- Completely randomized design, Randomized block design and Latin square design, Planning and analysis of factorial experiments, Split plot design, confounding- complete and partial. Layout of the field, Deciding plot size,

UNIT III: Recording of data or Observation

Rainfall, temperature, sunshine, and relative humidity, Soil analysis: Texture, bulk density, pH, organic carbon; Biometric observation Germination & Survival percent, Growth parameters, Yield and Yield attributing Traits and Qualitative traits.

UNIT IV: Horticultural Research Trials

Study of different horticultural research trials conducted by government and private institutions. Prepare a report on horticultural research trials by partitioning it in Introduction, Objective, Review of literature and their citation, technical programme, observation to be recorded and possible outcomes.

UNIT V: Data Presentation and Writing Skills

Diagrammatic presentation and its types, Collection of review of literature, Writing of bibliography, Preparation of synopsis. Writing of Abstract, Research paper, Popular articles, Presentation of research paper.

SUPPORTING COURSES

STAT 502 Statistical Methods for Applied Sciences

3(2+1)

Aim of the course

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

Theory

Unit I

Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation.

Unit II

Discrete and continuous probability distributions, Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions.

Unit III

Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination, Fitting of quadratic models.

Unit IV

Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test.

Unit V

Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Introduction to Multivariate Analysis, Transformation of Data.

Practical

- Exploratory data analysis, fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal.

- Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F.
- Confidence interval estimation and Correlation and regression analysis, fitting of Linear and Quadratic Model.
- Non-parametric tests. ANOVA: One way, Two Way, SRS.

Suggested Reading

Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.

Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.

Hoel P.G. 1971. Introduction to Mathematical Statistics. John Wiley.

Hogg R.V and Craig T.T. 1978. Introduction to Mathematical Statistics. Macmillan.

Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.

Hogg RV, McKean JW, Craig AT. 2012. Introduction to Mathematical Statistics 7th Edition.

Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.

Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed . John Wiley.

<http://freestatistics.altervista.org/en/learning.php>. • <http://www.statsoft.com/textbook/stathome.html>.

STAT 511 Experimental Designs

3(2+1)

Aim of the course

This course is meant for students of agricultural and animal sciences other than Agricultural Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

Unit I

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

Unit II

Uniformity trials, size and shape of plots and blocks, Analysis of variance, Completely randomized design, randomized block design and Latin square design.

Unit III

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.

Unit IV

Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications, Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

Practical

- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, Analysis of data obtained from CRD, RBD, LSD, Analysis of factorial experiments,
- Analysis with missing data,
- Split plot and strip plot designs.

Suggested Reading

Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.

Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.

Montgomery DC. 2012. Design and Analysis of Experiments, 8th Ed. John Wiley.

Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.

Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley. www.drs.icar.gov.in.

COMMON COURSES

PGS 501 LIBRARY AND INFORMATION SERVICES

(0+1)

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

Practical:

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

PGS 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS

(0+1)

Objective: To equip the students/ scholars with skills to write dissertations, research papers, etc. To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical (Technical Writing)

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.;

- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
- Writing of abstracts, summaries, précis, citations, etc.; Commonly used abbreviations in the theses and research communications;
- Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations;
- Writing of numbers and dates in scientific write-ups;
- Editing and proof-reading;
- Writing of a review article;
- Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); • Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription; • Accentual pattern: Weak forms in connected speech;
- Participation in group discussion;
- Facing an interview;
- Presentation of scientific papers.

Suggested Readings

Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995.

Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.

Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.

James HS. 1994. Handbook for Technical Writing. NTC Business Books.

Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.

Mohan K. 2005. Speaking English Effectively. MacMillan India.

Richard WS. 1969. Technical Writing.

Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.

Wren PC and Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (1+0)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPs Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
Rothschild M and 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; The Biological Diversity Act, 2002

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 and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

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

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 and 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.