

HORTICULTURE
Ph.D Course Work Syllabus

Course Code	Course title	Credits
HOR-RS-C101	Research Methodology	4
HOR-RS-C102	Research Proposal and Seminar	4
HOR-RS-C103	Advances in Fruit Production	4
HOR-RS-C104	Advances in Vegetable production	4
HOR-RS-C105	Advances in Floriculture and Landscape Architecture	4
HOR-RS-C106	Advances in Plantation, Spices, Medicinal & Aromatic plants	4
	Total	12

HOR-RS-C101: RESEARCH METHODOLOGY

Unit I- Research Design and Data Collection

Research methodology- definition, different types of research design. Basic principles of experimental designs. Sampling design- sample survey, steps in sample design, criteria of selecting a sampling procedure and different types of sample designs. Methods of Data Collection: Primary and secondary data. Literature collection and citation, bibliography. Writing skills - Preparation of research report, presentations, and writing scientific paper. Impact factor, Citation factor, Plagiarism, ISBN, ISSN.

Unit II: Processing and Analysis of Data and Sampling

Processing operations, elements/types of analysis, statistics in research, measures of central tendency, dispersion, asymmetry, relationships. Simple regression analysis, multiple correlation and regression, partial correlation, association in case of attributes and other measures.

Unit III: Testing of Hypotheses

Basic concepts of testing of hypothesis, procedures for hypothesis testing. Hypothesis testing for differences between means, hypothesis testing for comparing two related samples, hypothesis testing of proportions. Testing the equality of variances of two normal populations, hypothesis testing of correlation coefficient. Chi square test

Unit IV: Analysis of Variance and Covariance

Analysis of Variance and Covariance (basic principles of one-way ANOVA, two-way ANOVA and ANCOVA). Multivariate analysis techniques (Characteristics and applications, classification of Multivariate analysis, important multivariate techniques, important method of factor analysis). Ethics in research.

Reading List:

1. Bernard Rosner, B. 2005. Fundamentals of Biostatistics, 6th edition Duxbury Press.
2. Gerry, Q. P and Keough, M. J. 2002. Experimental Design and Data Analysis for Biologists. Cambridge Univ. Press.
3. Kothari, C.R. 2004. Research Methodology, Methods & Techniques. 2nd Revised Edition. New Age International Publisher, India.
4. Norman, N. G. and Streiner, D. 2008. Biostatistics: The Bare Essentials. 3rd edition, BC Decker Inc.
5. Paulson, D. S. 2008. Biostatistics and Microbiology. Springer.

6. Sokal, R. R. and Rohlf, F. J. 2008. Introduction to Biostatistics. Dover Publication.
7. Laake, P., Benestat, H.B. and Olsen, B.R. 2007. Research Methodology in the Medical and the Biological Sciences. Academic Press, UK.

HOR-RS-C102: Research Proposal and Seminar

Review of research literature, identification of research problems and gaps, writing research proposal, preparation of a real time budget and infrastructure requirements. (It is non lecture based paper in which the candidates review the literature and write a research proposal (synopsis) in the area of research interest. There will be no sessional tests and no attendance requirement for this paper. Students also have to deliver two compulsory doctoral Seminar of one credit each in this course.

Fruit Sciences

HOR-RS-C103: ADVANCES IN FRUIT PRODUCTION

Unit I: ADVANCES IN PRODUCTION OF FRUIT CROPS

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). Special production problems like alternate bearing in mango, apple, seediness and kokkan disease in banana, citrus decline, bud forecasting in grapes, guava wilt

Crops: Mango and banana, papaya, grapes and citrus, guava, sapota, pomegranate and aonla, pineapple, avocado, jack fruit and fig, apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Unit II : ADVANCES IN GROWTH REGULATION OF FRUIT CROPS

Ecophysiological influences on growth and development of fruit crops flowering, fruit set- Crop load and assimilate partitioning and distribution. Root and canopy regulation, study of plant growth regulators in fruit culture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards. Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production. Flower drop and thinning, fruitset and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation.

Unit III: BIOTIC AND ABIOTIC STRESS MANAGEMENT IN FRUIT CROPS

Impact of stress in fruit crop production, stress indices, physiological and biochemical factors associated with stress, fruit crops suitable for different stress situations.

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.

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, cropping systems, stability and sustainability indices. Visit to orchards and watershed locations.

Unit IV: ADVANCES IN BREEDING OF FRUIT CROPS

Evolutionary mechanisms, adaptation and domestication, Genetic resources, cytogenetics, cytomorphology, chemotaxonomy, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits, recent advances in crop improvement efforts for different fruit crops

Crops: Mango and banana, papaya, grapes and citrus, guava and sapota, pineapple and avocado, apple, pear, plums, peaches, apricot, cherries and strawberry

Reading List:

1. Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits – Horticulture*. Allied Publ.
2. Bose TK, Mitra SK & Sanyal D. (Eds.). 2001. *Fruits -Tropical and Subtropical*. Naya Udyog.
3. Chadha KL & Pareek OP. (Eds.).1996. *Advances in Horticulture*. Vols. IIIIV. Malhotra Publishing House.
4. Fosket DE. 1994. *Plant Growth and Development: A Molecular Approach*. Academic Press.
5. Leopold AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3rd Ed. McGraw-Hill.
6. Maloo SR. 2003. *Abiotic Stress and Crop Productivity*. Agrotech Publ. Academy.
7. Mussell H & Staples R. 1979. *Stress Physiology in Crop Plants*. Wiley Inter. Science.

Vegetable Sciences

HOR-RS-C104: ADVANCES IN VEGETABLE PRODUCTION

Unit I: Advances in production technology

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 modal vegetable crops.

Unit II: Advances in Vegetable breeding

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature;

toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance of modal vegetable crops.

Unit III: Seed certification, storage and processing

Seed certification, objectives, organization of seed certification, minimum seed certification standards of vegetable crops, field inspection, specification for certification. Seed processing, study of seed processing equipments seed cleaning and upgrading, Seed packing and handling, equipment used for packaging of seeds, procedures for allocating lot number. Pre-conditioning, seed treatment, benefits, types and products, general principles of seed storage, advances in methods of storage, quality control in storage, storage containers, seed longevity and deterioration, sanitation, temperature and relative humidity control. Seed testing; ISTA rules for testing, moisture, purity germination, vigor test, seed sampling, determination of genuineness of varieties, seed viability, seed health testing; seed dormancy and types of dormancy, factors responsible for dormancy. Seed marketing, demand forecast, marketing organization, economics of seed production; farmers' rights, seed law enforcement, seed act and seed policy.

Unit IV: Abiotic stress management

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. Mechanism and measurements of tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops. Soil-plant-water relations under different stress conditions in vegetable crops production and their management practices. Techniques of vegetable growing under water deficit, water logging, salinity and sodicity. Techniques of vegetable growing under high and low temperature conditions, use of chemicals in alleviation of different stresses.

Reading List:

1. Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
2. Kallo G & Singh K. (Ed.). 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.
3. Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable production*. International Book Distr. Co.
4. Peter KV & Pradeep Kumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised Ed.). ICAR.
5. Ram HH. 2001. *Vegetable Breeding*. Kalyani.
6. Dwivedi P & Dwivedi RS. 2005. *Physiology of Abiotic stress in Plants*. Agrobios.
7. Maloo SR. 2003. *Abiotic Stresses and Crop Productivity*. Agrotech Publ. Academy.

Floriculture

HOR-RS-C105: ADVANCES IN FLORICULTURE AND LANDSCAPE ARCHITECTURE

UNIT I: Advances in Floriculture Biochemistry

Biochemistry of flowers: Principle involved in the formation of pigments – chlorophyll, xanthophyll, carotenoids, flavonoids and anthocyanins. Chemistry and importance of secondary metabolites in rose, jasmine, marigold, tuberose, carnation, orchids, liliams and bougainvillea.

Biochemistry and utilization commercial products (select items). Recent trends- Extraction of biocolours and their value addition, uses in food and textile industries. Biochemistry of post harvest management of cut flowers. Floral oil industry, floral concrete production, extraction methods, recent advances.

UNIT II: Advances in Floriculture Biotechnology

Biotechnology – tools techniques and role in floriculture industry, *In vitro* lines for biotic and abiotic stress, molecular approaches to control ethylene response, improving shelf life, improving resistance for environmental stress, approaches to improve flower development, pigment production, secondary metabolite production, post harvest biotechnology of flowers, ornamental plants, achievements of biotechnology in flower crops.

UNIT III: Precision Floriculture

Precision floriculture, Principles and concepts, crop modeling, enabling technologies of precision farming, GPS, GIS, Remote sensing, sensors. Variability management in precision farming, mapping, variable rate technology, precision equipments, computers and robotics in precision farming, post-harvest process management in floriculture using precision farming.

UNIT IV: Advances Landscape Architecture

Expenses to model landscaping units of all category, Creativity and communication skills for landscape architect, Way of designing a commercial landscape project. Preparation and drawing of site plan, Learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials (AUTOCAD & ARCHICAD), GIS as a tool for spatial designing. Case study with the successful landscapist, Budget / Project cost estimating, Execution strategies, Assessing a successful design in site.

Reading List:

1. Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
2. Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices*. Agrobios.
3. Reddy S, Janakiram B, Balaji T, Kulkarni. S & Misra RL. 2007. *Hightech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi.
4. Leopold AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3rd Ed. McGraw-Hill.
5. Maloo SR. 2003. *Abiotic Stress and Crop Productivity*. Agrotech Publ. Academy.
6. Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. (Eds.). 2007. *Recent Trends in Horticultural Biotechnology*. Vols. I & II. New India Publishing Agency.
7. Singh HP, Singh G, Samuel JC & Pathak RK. (Eds.). 2003. *Precision Farming in Horticulture*. NCPAH, DAC/PFDC, CISH, Lucknow.

Plantation, Spices, Medicinal & Aromatic Plants

HOR-RS-C106: ADVANCES IN PLANTATION, SPICES, MEDICINAL & AROMATIC PLANTS

UNIT I: Medicinal Plants

Post-harvest handling of plant material, preparation of plant material for packaging and extraction. Methods of extraction of secondary metabolites from medicinal crops like sarpagandha, steroid-bearing solanums, ashwagandha, henbane, periwinkle, senna, costus, coleus, etc.

Procedures and equipments used for extraction of active principles. Principles and practices of different types of chromatographs - paper, thinlayer, column, gas and high performance liquid chromatography and mass spectroscopy. Preservation of plant extracts and their trade mechanisms.

UNIT II: Aromatic Plants

Harvesting, drying, handling and preparation of different aromatic crops -jasmine, tuberose, oil-bearing rose, scented geranium, patchouli, davana, mints, basils, etc., for essential oil extraction.

Principles and practices of different types of extraction - distillation, solvent extraction, supercritical fluid extraction, etc. Fine flavour and perfume extraction. Qualitative determination of essential oils. *In vitro* production of biomass and organic extraction of oils. Quality analysis and characterization through chromatographs.

UNIT III: Non-Conventional Breeding Methods

In vitro culture methods and molecular approaches for crop improvement in plantation crops and spices, production of haploids, disease elimination in horticultural crops, micro grafting; somocloning and identification of somaclonal variants, *in vitro* techniques to overcome fertilization barriers, *in vitro* production of secondary metabolites, *in vitro* conservation of spices and plantation crops.

UNIT IV: Biotechnological applications

In vitro mutation for biotic and abiotic stresses, Quality improvement; improvement for biotic and abiotic stresses; transgenic plants, Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars etc., achievements, problems and future thrusts in horticultural biotechnology, Metabolomics in spices and medicinal crops

Reading List:

1. Farooqi AA, Khan MM & Vasundhara M. 2001. Production Technology of Medicinal and Aromatic Crops. Natural Remedies Pvt. Ltd.
2. Khan IA & Khanum A. Role of Bio Technology in Medicinal and Aromatic Plants. Vol. IX. Vkaaz Publ.
3. Bajaj YPS. (Ed.). 1987. Biotechnology in Agriculture and Forestry. Springer.
4. Chadha KL, Ravindran PN & Sahijram L. (Eds.). 2000. Biotechnology of Horticulture and Plantation Crops. Malhotra Publ. House.
5. Debnath M. 2005. Tools and Techniques of Biotechnology. Pointer Publ.
6. WHO. 1998. Quality Control Methods for Medicinal Plants Materials. WHO. 83
7. Pradeep kumar T, Suma B, Jyothi bhaskar & Satheesan KN. 2007. *Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.