Department of Seed Science & Technology

Ph.D Programme

Course No.	*Title of the course*	*Credits*
1st Semester		
SST -701	Hybrid Seed Production	2+1
SST-702	Seed Structure and Development	2+1
SST-703	Testing of Genuineness and Purity of Cultivars	1+1
SST-704	DUS Testing for Plant Variety Protection	2+1
SST-705	Advances in Seed Science Research	1+0
2nd Semester		
SST-751	Seed Production in Forage, Pasture and Green Manure Crops	2+1
SST-752	Principles of Seed Production Technology	2+2
SST-753	Seed Health	2+1
SST-754	Seed Testing and Quality Control	2+1
SST-799	Seminar-I	1+0
3rd Semester		
SST-801	Emerging Trend in Seed Quality Enhancement	1+1
SST-802	Seed Storage and Deterioration	2+1
SST-803	Methods of Seed Production of Medicinal and Aromatic plants	1+1
SST-849	Seminar-II	0+1
4th Semester		
SST-851	Seed Marketing and Management	2+1
SST-852	Seed Production of Fruits and Plantation Crops	2+1

5th Semester		
	Nil	
6th Semester		
SST-999	Seminar-III	1+0
SST-1000	Doctoral Research	0+45

Ph.D Programme

SST-701 Hybrid Seed Production 2+1

Theory

UNIT I: Heterosis : definition, expression and estimation of hybrid vigour; utilization of heterosis in agricultural, horticultural and other crop plants for crop improvement.

UNIT II: Pre requisites for hybrid seed production; mechanisms and management of pollination in autogamous and allogamous crops; genetic constitution of varieties, hybrids and basic principles in seed production.

UNIT III: Techniques of hybrid seed production – emasculation and crossing : use of self-incompatibility, modification of sex; types of male sterility and exploitation in hybrid development and its use in hybrid seed production; development and maintenance of A, B and R lines.

UNIT IV: Fertility restoration; use of chemical hybridizing agents, problems of non synchrony in flowering of parental lines and methods to overcome; planting ratios and population density in relation to hybrid seed yield; salient features of hybrid seed production of various crops viz. rice, sorghum, bajra, maize, sunflower, cotton and other major vegetables.

Practical

Methods of hybrid seed production in major agricultural and horticultural crops; planting of rows/blocks of parental lines and manipulations for achieving flowering

synchromy for production of hybrid seeds, maintenance of A, B and R lines and production of breeder seed; stable diagnostic characteristics of parental lines and their hybrids; genetic purity tests; determination of cost of hybrid seed production of various crops; visit to seed production plots etc.

SST-702 Seed Structure and Development 2+1

Flower type, floral structure in relation to seed development. Microsporogenesis and megasporogenesis. Development and structure of megasporangium, microsporangium. Gametogenesis : male and female gametophyte development and structure. Pollination mechanism and control of pollination. Fertilization : barriers to fertilization, incompatibility and male sterility. Embryogenesis : development of typical monocot and dicot embryo. Endosperm development, modification of food storage structures with reference to crop plants. Different types of embryo, endosperm and cotyledons, development and structure in representative crop plants with reference to food storage. Seed structure : external and internal features of monocot and dicot seed. Seed maturation. Apomixis – classification, significance and its utilization in different crops for hybrid seed production. Polyembryony : types and significance. Seed-coat structure and development in representative crop plants. Seed-coat permeability. Seed sterility and its causes, haplontic and diplontic sterility. Causes of embryo abortion.

Practical

Study of floral biology of monocot and dicots. Seed-coat : its structure, texture in relation to permeability, imbibition of water. Heterostyly. Micro and megasporogenesis. Pollen morphology, pollen germination and pollen sterility. Monocot and dicot embryos. Eternal and internal structure of monocot and dicot seeds. Maturity indices.

SST-703 Testing for Genuineness and Purity of Cultivars 1 + 1

Theory

UNIT I: Objective of cultivar purity test, general principles and methods involved. Use and limitations of laboratory, green house and field plot methods in determination of genuineness of cultivars; a case study in hybrid cotton, reporting of results and inference.

UNIT II: Chemical-biochemical tests for species and cultivar purity : phenol test, seed and seedling tests, electrophoretic analysis of seed protein, isozymes etc. use of chromatography for analysis of secondary compounds etc.

UNIT III: DNA finger printing (RAPD, SSR, AFLP etc.) and their use in varietal purity testing and registration of new varieties.

UNIT IV: Use of computer-based machine vision (MVT) for varietal identification and purity testing.

Practical

Chemical and biochemical tests for species and cultivar purity: phenol test, seed and seedling tests. Determination of physical purity and genetic purity.

SST-704 DUS Testing for Plant Variety Protection 2+1

Theory

UNIT I: Genesis of plant variety protection (PVP); International Union for Protection of New Varieties of Plants (UPOV) and its functions; General agreements on Tarif and Trades (GATT) agreement in relation to protection of plant varieties; Protection of Plant Varieties and Farmers Rights (PPV & ER) Act, 2001; PPV & FR rules, 2003.

UNIT II: Criteria for protection of new varieties of plants; principles and procedures of Distinctness, uniformity and Stability (DUS) testing; test guidelines, planting material, duration, testing options, varieties of common knowledge, reference collection, grouping of varieties, types and categories of characters; technical questionnaire.

UNIT III: Assessment of DUS characters based on morphological, biochemical and molecular markers; statistical procedures; computer software for use in DUS testing

impact of PVC on growth of seed industry; practical exercise o DUS testing in rice, wheat, pearl-millet, maize, rose and cauliflower.

Practical

Morphological description of plant parts and plant; character expression and states, recording observation and interpretation of data; chemical tests and markers applicable for DUS tests and case study of selected crops.

SS-705 Advances in Seed Science Research 1+0

Theory

UNIT I: Physiological and molecular aspects of seed development and control of germination and dormancy; gene expression during seed development; desiccation and stress tolerance and conservation; prediction of seed dormancy and longevity using mathematical models; structural changes in membranes of developing seeds during acquisition of desiccation tolerance; dehydration damage and repair in imbibed seeds, seed biotechnology; genetic analysis and QTL mapping of germination traits; seed ageing and ethylene production; recent accomplishments in seed enhancement research and application of nanotechnology.

UNIT II: Modern techniques for identification of varieties and hybrids; principles and procedures of electrophoresis, machine vision technique, DNA fingerprinting and other molecular techniques and their utilization; techniques for improving seed quality; proteomic analysis; seed priming, coating, pelleting and synthetic seeds; GM seeds and their detection, terminator technology (GURT).

UNIT III: Detection and identification of seed borne fungi, bacteria, viruses, nematodes and insect pests through advanced techniques like ELISA, PCR based techniques etc.

UNIT IV: Seed production of self incompatible and apomictic plant species; recent developments in seed laws, policies and seed certification system in India and its

comparison with OECD seed certification schemes; IPR systems and PVR internationally.

SST-751 Seed Production in Forage, Pasture and Green Manure 2 + 1

Theory

UNIT 1: Important pasture ad forage legume crops in India; seed requirement and production; classification of forage, pastures and green manure crops; pollination behaviour.

UNIT II: Factors influencing seed production; maintenance of varietal purity, generation systems of seed multiplication self pollinated crops; seed production in apomictic grasses.

UNIT III: Methods and techniques of seed production in important grasses, pastures, legumes and green manure crops; apomictic seed.

UNIT IV: Selection of seed production areas, influence of season, seed rate and spacing, sowing methods, direct seed sowing, transplanting, pelleting, fertilizer and manure requirement, isolation distance, weed control, pollination and seed setting, seed shattering, seed maturity and stage of harvest, seed collection, economics of seed production of important fodder crops.

UNIT V: Seed processing, seed treatment, seed viability of these crops.

Practical

Study of flower structure, seed collection and identification, characteristics of forage, pastures and green manure crops; maturity indices for harvest, seed testing – sampling purity, moisture, germination and dormancy, seed treatments.

SST-752 Principles of Seed Production Technology 2+2

Seed industry development. Classification of crop plants in relation to mode of reproduction, Variety : definition, type, development, release system and notification. Objectives of seed production, generation system. Factors affecting seed production; site

selection; isolation and rouging; compact area approach. Variety maintenance, nucleus and breeder seed production in different crop groups. Hybrid seed production; heterosis; inbreeding depression; genetic, physiological and bio-chemical basis of heterosis. Two and three-line system of hybrid seed production. Development of A, B and R lines. Male sterility, its kind and use in hybrid seed production. Self-incompatibility, its genesis and use in hybrid seed production. Gametocides. Seed production planning.

Practical

Seed production planning in different crops with special reference to land and isolation requirements. Agronomic management, rouging, harvesting threshing. Characters of important varieties and its maintenance. Nucleus, breeder foundation and certified seed production in crops like wheat, rice, potato, chickpea, lentil and mustard.

Seed production planning in cross pollinated crops with special reference to land and isolation requirements, planting ratio of male and female parental lines, synchronization between male and female parental lines, methods to achieve synchronization, pollen collection, supplementary pollination, pollen storage, hand pollination in sunflower, hand emasculation and pollination in cotton, tomato and cucurbits, identification of male and female flowers in castor and its seed production management. Roguing. Detasselling, pollination in corn, pollen shedders identification. Gametocide application and observation of results, pollen collection, storage, viability and stigma receptivity. Application of GA_3 and supplementary pollination in hybrid rice. Visit to seed production plots of corn, pearl millet, sorghum, sunflower, castor, cotton and pigeonpea.

SST-753 Seed Health 2 + 1

Theory

History and economic importance of seed health. Range and importance of seed borne and clonally disseminated pathigene and insect pests. Factors influencing and contribution to development and spread of infection. Relationship of seed pathogens with diseases of major crops in field. Post harvest diseases and pests of the seeds of major crops, Deterioration and seed spoilage in storage. Field and storage pathogens and insect pests. Types of damage; contributing factors. Role of moisture content of seeds in storage. Organisms involved in seed spoilage. Effect on germination. Vigour and chemical changes due to infection. Control measures. Seed treatment benefits and defects. Seed fumigation. Seed health testing methods. Preservation of seeds on long term basis.

Quarantine – meaning, history, method, uses; National and International standards.

Practical

Isolation and identification of seed borne pathogens and insects. Isolation and identification of post harvest diseases and insects pests, Assessment of damages causes caused by diseases and insect attack in field and in storage; organisms responsible for this. Comparison of germination percentage form healthy and confected seeds. Determination of vigour and chemical changes in seed due to infection. Seed treatment by different methods. Procedures of seed health testing. Methods and procedures followed for quarantine.

SST-754 Seed Testing and Quality Control 2+1

National and international history of seed testing. Seed testing network in India. National and international seed testing rules. Seed testing organizations. Seed sampling, heterogeneity test. Sample receipt and registration. Physical purity analysis. Determination of other seeds by number and determination of other distinguishable for different crops, seeding evaluation. Moisture test. Tetrazolium test – principles, procedure and evaluation. Testing for coated/pelleted seeds. Testing for varietal

verification, grow-out test. Sed health. Insect damage. Reporting of seed testing results. Laboratory layout, furnishing and management. Variability in seed testing results, factors affecting variability, use of tolerance tables in seed testing. Sequential sampling analysis. Seed dormancy, types and methods to break it. Weed seed identification. Preservation and storage of guard samples.

History of seed quality control. Importance of good quality seed. Seed quality standards – definition and concept. Seed quality components and field standards. Concept and purpose and phases of seed certification. Certification agency. Variety eligibility, class and sources of seed, verification of seed source. Unit of certification, field inspection and reporting of results, comparing field observations with minimum standards, grow-out test, tolerance levels. Seed analyst and his duties. Laboratory evaluation and packaging, seed lot size and construction of seed lot number, certified seed label, certification tag, validity period of certification. Seeds Act and seed rules and law enforcement. Seed control order. Seed policy. Seed inspectors-powers and duties, inspection procedures and equipments required.

OECD-role of OECD in standardizing the seed certification procedures. UPOV-role of UPOV in international seed trade. Consumers Protection Act. Weighs and Measures Act and Packaging Act.

Practical

Sampling and submission of samples to seed testing laboratory, sample registration, determination of the relative efficacy of various mixing and dividing techniques, obtaining working sample, physical purity analysis and reporting results. Testing of the germination substrata and determination of substrate quality, and reporting results. Methods of breaking dormancy, Tetrazolium test. Moisture test-oven method, moisture meters. Visit to state seed testing laboratory, Determination of ODV.

Field inspection at different crop growth stages – taking field counts in different crops. Offtypes, pollen shedders, designated seed borne diseases, counts of the male and female parents in hybrid seed production, field inspection report for different crops, field area measurements, isolation distances.

SST-801 Emerging Trends in Seed Quality Enhancement 1 + 1

Theory

UNIT I: Concept and significance of seed quality enhancement; physical, chemical and pesticidal seed treatments, history, principles and methods of seed treatment, methodology and factors affecting seed enhancement treatments.

UNIT II: Seed priming : physiological and biochemical basis, types of priming technology, biochemical and molecular changes associated, pregermination, film coating and pelleting, seed tapes, seed mats, seed colouring, biopriming.

UNIT III: Synthetic seeds – Aim and scope for synthetic seeds, historical development, somatic embryogenesis, somaclonal variation and their control, embryo encapsulation systems, hardening of artificial seeds, cryopreservation, storage of artificial seeds, desiccation tolerance, use of botanicals in improving seed quality etc.

Practical

Seed treatments – methods and techniques, equipments required for seed treatment, film coating; seed invigoration/priming – hydration and dehydration, PEG priming, solid matrix priming, bio priming, effects of priming; methods for hydrogel encapsulation of artificial endosperm, hydrophobic coating etc.; protocols for production of synthetic seeds, Visit to leading Seed companies to study the seed treatment processes.

SST-802 Seed Storage and Deterioration 2 + 1

Theory

UNIT I: Life span of seeds of plant species; classification of seeds on the basis of storage behaviour; orthodox and recalcitrant seeds : types of storage; kinds of seed storage

(open, bulk, controlled, hermetic, germplasm, cryopreservation); soil seed bank; terminology; survival curve of seed.

UNIT II: Factors affecting seed storability – biotic and abiotic and pre- and postharvest factors affecting seed longevity; the effects of packaging materials, storage fungi and insects, seed treatment and fumigation and storage environmental conditions on seed storability; moisture equilibrium in seeds; selection of suitable areas/places for safe storage; prediction of relative storability and longevity of seed lots, viability equations and nomographs.

UNIT III: Concept of seed ageing and deterioration, different changes associated with the loss of vigour and viability during storage; application of physiological and biochemical techniques for evaluation of seed ageing; genetics of seed viability; effect of seed ageing on crop performance; maintenance of viability and vigour during storage; seed amelioration techniques, mid storage corrections etc.

UNIT IV: Storage methods, and their impact on short and long term storage; methods of safe seed storage including eco-friendly techniques used in various group of crops viz. cereals, pulses, oilseeds, fibers, forages and vegetables; operation and management of seed stores; fruit storage; viability loss during transportation and interim storage.

Practical

To study the effect of storage environmental factors (RH, SMC and temperature) on seed longevity; to study the effect of packaging materials, seed treatment and fumigation on storability; prediction of storability and longevity of seed-lots by using viability equations and nomographs; standardization of accelerated ageing (AA) technique for assessing the seed storability of various crops; estimation of carbohydrates, proteins, fats, enzyme activities, respiration rate and nucleic acids in fresh and aged seeds; use of eco-friendly products and amelioration techniques to enhance quality of stored seeds, visit to seed stores.

SST-803 Methods of seed production of medicinal and aromatic plants 1 + 1

Theory

1. Background, Objectives

2. Medicinal Plants and their Cultivation

Medicinal plants under cultivation, Area under medicinal plants cultivation

3. Medicinal Plants Nurseries

Significance of a nursery, medicinal plants nursery,Medicinal plants that contribute to village economy

4. Principles of Nursery Management

Site selection; Design and layout,Land clearing, Development of infrastructure,Equipment & tools, Demand assessment & species choice,Managing the nursery and Seedlings distribution.

5. Principles of Plant Propagation

Definition; Significance of propagation; Methods of plant propagation;**(A)**Sexual method of propagation- Advantages and limitations of sexual propagation,seed dormancy and seed viability ,**(B)**Asexual method of propagation - Advantages and limitations, different methods of asexual propagation - a. Propagation through cuttings , b. Propagation through layering , c. Propagation through grafting , d. Propagation through budding, e. Propagation through modified organs.

6. Propagation techniques of medicinal plants

Propagation details of different medicinal and aromatic plants, as-

Herbs

1. *Andrographispaniculata, 2. Catharanthusroseus, 3. Cyperusrotundus,4. Cyperusscariosus,5. Solanumnigrum*

Shrubs

1. *Abelmoschusmoschatus,2. Acacia sinuata,3. Rauvolfiaserpentina,*4. Ashwagandha(*Withaniasomnifera* L. Dunal), 5. Datura (*Daturastramonium* L.)

Climbers

1. *Asparagus racemosus, 2. Piper longum*

Trees

1. *Aeglemarmelos, 2. Azadirachtaindica, 3. Cassia fistula, 4.Terminaliabellirica,*
5. *Terminaliachebula*

Propagation techniques of aromatic plants

Lemon grass (*Cymbopogonflexuosus*), Java citronella (*Cymbopogonwinterianus*)

Practical

Identification of seed; Identification of plants; Production of propagules and seeds; preparation of a nursery and its management; Herbarium preparation on economic parts of different plants.

SST-851 Seed Marketing and Management 2 + 1

Theory

UNIT I: Importance and promotion of quality seed, formal and informal seed supply systems. Basic concepts of marketing with special reference to seed; importance and scope of seed industry in India, major constraints/problems in seed industry/seed sector role of seed association / federation in seed trade.

UNIT II: Demand and supply of seed; Role of seed replacement rate (SRR), seed multiplication ratio (SMR), cost of production and returns; determining seed needs; seed pricing and price policy, seed processing and/packaging demand forecasting.

UNIT III: Seed marketing intelligence and product mix, sales promotion, distribution channels, marketing costs and margins.

UNIT IV: Salient features of national seed politics, role of various sectors/agencies in efficient seed marketing, quality control and assurance programme. Responsibilities of seed companies and dealers under Seed Act, EXIM policies for seed trade etc.

Practical

Statutory requirements in seed business including R&D, estimation of cost of seed production, marketing costs and margins of seeds of different crops, case studies to compare public & private sectors in different conditions, impact analysis seed pricing, cost benefit ratio, economic feasibility of seed industry etc.

SST-852 Seed Production of Fruits and Plantation Crops 2+1

Seed production and handling in perennial fruit crops like mango, guava, papaya, citrus, ber, amla, and jamun. Seed collection and viability maintenance. Germination; problems and improvements. Vegetative propagation. Seed production and handling in plantation crops like coffee, tea, cocoa, rubber, cardamom, pepper, clove, coconut, nutmeg, arecanut. Seed collection and viability maintenance.

Practical

Isolation distance determination, floral biology, maturity indices, selection of trees, seed collection, assessment of critical moisture, maintenance of viability in recalcitrant seeds, germination improvement, visit to seed orchards.

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