SEED SCIENCE AND TECHNOLOGY
Course Structure - at a glance

CODE	COURSE TITLE	CREDITS
SST 501*	FLORAL BIOLOGY, SEED DEVELOPMENT AND MATURATION	1+1
SST 502*	PRINCIPLES OF SEED PRODUCTION	2+0
SST 503*	SEED PRODUCTION IN FIELD CROPS	2+1
SST 504	SEED PRODUCTION IN VEGETABLES	2+1
SST 505	SEED PRODUCTION IN FLOWER, MEDICINAL, FRUIT AND PLANTATION CROPS	2+1
SST 506*	SEED LEGISLATION AND CERTIFICATION	2+1
SST 507*	SEED PROCESSING AND STORAGE	2+1
SST 508*	SEED QUALITY TESTING	2+1
SST 509@@@	SEED PHYSIOLOGY	2+1
SST 510	SEED PATHOLOGY	2+1
SST 511	SEED ENTOMOLOGY	2+1
SST 512	SEED PRODUCTION IN FORAGE, PASTURE AND GREEN MANURE CROPS	2+1
SST 513	SEED STORAGE AND DETERIORATION	1+1
SST 514	SEED MARKETING AND MANAGEMENT	1+1
SST 515	EMERGING TRENDS IN SEED QUALITY ENHANCEMNT	1+1
SST 516 @	GERMPLASM COLLECTION, EXCHANGE AND QUARANTINE	2+1
SST 591	MASTER'S SEMINAR	1+0
SST 599	MASTER'S RESEARCH	20
SST 500 *	PROJECT WORK	0+4
SST 601**	HYBRID SEED PRODUCTION	1+1
SST 602@@	IN SITU AND EX SITU CONSERVATION OF GERMPLASM	2+1
SST 603	TESTING FOR GENUINENESS AND PURITY OF CULTIVARS	1+1
SST 604**	DUS TESTING FOR PLANT VARIETY PROTECTION	2+1
SST 605**	ADVANCES IN SEED SCIENCE RESEARCH	1+0
SST 691	DOCTORAL SEMINAR I	1+0
SST 692	DOCTORAL SEMINAR II	1+0
SST 699	DOCTORAL RESEARCH	45

Compulsory for Master's programme*; * Compulsory for Ph. D. programme*

@ Cross listed with GP 516; @@ Cross listed with GP 610 and

SST 509 @@@ cross listed with PP 608

Minor Departments

Genetics and Plant Breeding

Plant Physiology

Plant Pathology

Entomology

Agricultural Engineering

Agricultural Economics

Agronomy

Biochemistry

Supporting Departments

Statistics and Mathematics

Plant Molecular Biology and Biotechnology

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	Library information services	0+1
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

SST 500* Title: Project work and credits (0+4): Students will be attached to Public/Private seed industry during III semester for project work / training equivalent to 0+4 credits. After completing the training programme the student has to appear for an examination to be conducted by the teacher/s – in charge/ advisor and a representative from the seed industry.

SST 501 FLORAL BIOLOGY, SEED DEVELOPMENT AND MATURATION 1+1

Objective

To refresh the basic knowledge of seed development and structures and apprise students with its relevance to production of quality seed.

Theory

UNIT I

Floral types, structure and biology in relation to pollination mechanisms; sporogenesis: microsporogenesis and megasporogenesis; gametogenesis - development of male and female gametes and their structures; effect of environmental factors on floral biology.

UNIT II

Fertilization – embryo sac structure, process, barriers to fertilization, incompatibility and male sterility, factors affecting fertilization.

UNIT III

Embryogenesis - development of typical monocot and dicot embryos; endosperm development, modification of food storage structures with reference to crop plants; different types of embryos, endosperm and cotyledons; development and their structure in representative crop plants with reference to food storage; external and internal features of monocot and dicot seed; seed coat structure and development in representative crop plants. Physiological cum harvestable maturity with reference to germination and seed vigour, and fixing up of indices for seed harvesting; influence of weather, nutrition, soil moisture, plant protection chemicals, hormones and other cultural and management practices on seed development and maturation.

UNIT IV

Apomixis – identification, classification, significance and its utilization in different crops for hybrid seed production; Polyembryony - types and significance; haplontic and diplontic sterility, causes of embryo abortion, embryo rescue, and synthetic seeds, desiccation tolerance - role of LEA proteins and oligo saccharides.

Practical

Study of floral biology of monocots and dicots; microsporogenesis and megasporogenesis; study of pollen grains - pollen morphology, pollen germination and pollen sterility; types monocot and dicot embryos; external and internal structures of monocot and dicot seeds; seed coat structure, preparation of seed albums and identification; Study of physiological and harvestable maturity - morphological and chemical indices

Suggested Readings

Bhojwani SS & Bhatnagar SP. 1999. *The Embryology of Angiosperm*.Vikas Publ.

Black M, Bewley D & Halmer P. 2006. *The Encyclopedia of Seeds: Science, Technology and Uses*. CABI.

Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*. Deptt. of Plant Breeding, CCS HAU, Hisar.

Copeland LO & McDonald MB. 2001. *Principles of Seed Science and Technology*. 4th Ed. Chapman & Hall.

Frankel R & Galun E. 1977. *Pollination Mechanisms, Reproduction and Plant Breeding*. Springer Verlag.

SST 502 PRINCIPLES OF SEED PRODUCTION 2+0

Objective

To introduce the basic principles of quality seed production.

Theory

UNIT I

Introduction : Seed as basic input in agriculture; seed development in cultivated plants; seed quality concept and importance of genetic purity in seed production; types of cultivars, their maintenance and factors responsible for deterioration; seed production in self and cross pollinated crops.

UNIT II

Mode of pollination and reproduction in crop plants and their modification in relation to hybrid seed production. Principles of hybrid seed production, isolation distance, synchronization of flowering, roguing etc. male sterility and incompatibility system in hybrid seed production, role of pollinators and their management.

UNIT III

Seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, agronomy of seed production – agro climatic requirements and their influence on quality seed production; generation system of seed multiplication; maintenance of Nucleus seed, production of Breeder, Foundation and Certified seed– criteria involved; life span of a variety and causes for its deterioration; certification standards for self and cross pollinated and vegetatively propagated crops.

UNIT IV

Hybrid Seed - Methods of development of hybrids; use of male sterility and self-incompatibility and CHA in hybrid seed production; one, two and three line system; maintenance of parental lines of hybrids; planning and management of hybrid seed production technology of major field crops and vegetables.

UNIT V

Planning of seed production for different classes of seeds for self and cross pollinated crops, Seed quality control system and organization, seed village concept - Participatory seed production.; Seed production agencies, seed industry and custom seed production in India.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*.Dept. of Plant Breeding CCS HAU, Hisar.

Desai BB. 2004. *Seeds Handbook*. Marcel Dekker.

Kelly AF. 1988. *Seed Production of Agricultural Crops*. Longman.

McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.

Musil AF. 1967. *Identification of Crop and Weed Seeds*. Handbook No. 219, USDA, Washington, DC, USA.

Poehlman JM & Sleper DA. 2006. *Breeding Field Crops*. Blackwell.

Singh BD. 2005. *Plant Breeding: Principles and Methods*. Kalyani.

Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.

Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.

Tunwar NS & Singh SV. 1985. *Handbook of Cultivars*. CSCB, GOI.

SST 503 SEED PRODUCTION IN FIELD CROPS 2+1

Objective

To impart a comprehensive knowledge of seed production in field crops with adequate practical training.

Theory

UNIT I

Basic principles in seed production and importance of quality seed. Floral structure, breeding and pollination mechanism in self-pollinated cereals and millets viz, wheat, barley, paddy, ragi etc.

UNIT II

Floral structure, breeding and pollination mechanism in cross-pollinated cereals and millets viz maize, sorghum, bajra etc ; methods and techniques of quality seed production in cross-pollinated cereals and millets.

UNIT III

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in pulses (pigeon pea, chick pea, green gram, black gram, field beans, peas, soybean, cowpea etc.).

UNIT IV

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in major oil seeds (groundnut, castor, sunflower, safflower, rape and mustard, linseed, sesame, Niger etc.).

UNIT V

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in commercial fibers (cotton, jute, mesta etc) and vegetatively propagated crops like sugar cane, potato, zinger, turmeric etc.

Practical

Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate; Seed production in cross pollinated crops with special reference to land, isolation, planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage; hand emasculation and pollination in Cotton, detasseling in Corn, identification of rogues and pollen shedders; Pollen collection, storage, viability and stigma receptivity; gametocide application, Working out cost – benefit ratio for different crops; and visits to seed production plots etc.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Kelly AF. 1988. *Seed Production of Agricultural Crops*. John Wiley.

McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.

Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.

SST 504 SEED PRODUCTION IN VEGETABLES 2+1

Objective

To impart a comprehensive knowledge of seed production in vegetable crops with adequate practical training.

Theory

UNIT I

Introduction; modes of propagation in vegetables. Seed morphology and development in vegetable seeds. Floral biology of these plant species; classification of vegetable crops based on pollination and reproduction behavior; steps in quality seed production; identification of suitable areas/locations for seed production of these crops.

UNIT II

Classification based on growth cycle and pollination behavior; methods of seed production; comparison between different methods e.g. seed-to-seed vs. root-to-seed method in radish; seed multiplication ratios in vegetables; pollination mechanisms; sex types, ratios and expression and modification of flowering pattern in cucurbits; nursery raising and transplanting stage.

UNIT III

Seed production technology of vegetables viz. solanaceous, cucurbitaceous, leguminous, malvaceous, cole crops, leafy vegetables, root, tuber and bulb crops and spices; harvesting/ picking stage and seed extraction in fruit vegetables; clonal propagation and multiplication in tuber crops e.g. Potato, sweet potato, colocasia, tapioca; seed-plot technique in potato tuber seed production; hybrid seed production technology of vegetable crops, TPS (true potato seed) and its production technique; hybrids in vegetables; maintenance of parental lines; use of male sterility and self incompatibility in hybrid seed production, environmental factors related to flowering/bolting in vegetable crops.

UNIT IV

Share of vegetable seeds in seed industry; importance and present status of vegetable industry; intellectual property rights and its implications, impact of PVP on growth of seed industry.

Practical

Selection of suitable areas/locations for high quality seed/planting material production; study of floral biology of vegetables, determination of planting ratios for hybrid seed production vegetables; use and maintenance of monoecious line in hybrid seed production of cucumber; exercises on emasculation and pollination; seed extraction methods and their effect on quality of vegetables; seed production technology of varieties and hybrids in vegetables.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Bose TK, Mitra SK and Sadhur NK 1990. Propagation of tropical and sub tropical horticultural crops. Naya Prakash, Calcutta.

Desai BB, Katecha, PM & Salunke DK.1997. *Seed Hand Book: Biology,Production, Processing and Storage*. Marcel Dekker.

Desai BB. 2004. *Seeds Handbook*. Marcel Dekker.

George RAT. 1980. *Vegetable Seed Technology. A Technical Guide toVegetable Seed Production, Processing, Storage and QualityControl.* FAO, Rome.

Hartman HT & Kester DE. 2000. *Plant Propagation: Principles and Practices*. Prentice Hall.

Kelly AF & George RAT. (Eds.).1998. *Encyclopedia of Seed Production of World Crops*. John Wiley & Sons.

McDonald MB Jr & Copeland LO. 1997. *Seed Production of Crops:Principles and Practices*. Chapman & Hall.

Salunkhe DK, Desai BB & Bhat RN. 1987. *Vegetable and Flower Seed Production*. Agricole Publ. Academy.

Singh SP. 2001. *Seed Production of Commercial Vegetables*.Agrotech.

Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.

Vanangamudi, K et al.,2006 Advances in seed science and Technology : (Vol II) Quality seed production in vegetable crops Agrobios (India), Jodhpur.

SST 505 SEED PRODUCTION IN FLOWER, MEDICINAL, FRUIT AND PLANTATION CROPS 2+1

Objective

To impart comprehensive knowledge of seed production in horticultural crops with adequate practical training.

Theory

UNIT I

Introduction: modes of propagation in fruits, flower and plantation crops. Floral biology of these plant species; classification of medicinal and horticultural crops based on pollination

and reproduction behavior; steps in quality seed production; identification of suitable areas/ locations for seed production of these crops.

UNIT II

Flowers and Medicinal Plants; classification based on growth cycle, reproduction and pollination behavior; nursery requirement, planning and management; technology for quality seed production in important flower species i.e. marigolds, petunias, dahlia, roses, gladiolus, tulips, chrysanthemum etc; development of hybrids and their seed production technology. Seed production technology of annual medicinal plants viz. isabgol, ashawagandha etc.

UNIT III

Fruit and Plantation Crops: role of seed in perennial plant species; classification based on reproduction and pollination behavior; polyembryony and its significance; nursery requirement, planning and management; clonal propagation and multiplication in tropical, sub-tropical and temperate fruits and plantation crops; seed orchards; seed collection, extraction and processing.

UNIT IV

IPR issues with special reference to floral and plantation crops.

Practical

Selection of suitable areas/locations for high quality seed/planting material production; study of floral biology of flowers, Fruits, Medicinal and plantation crops; Determination of planting ratios for hybrid seed production in flowers; Exercises on emasculation and pollination; Seed extraction methods and their effect on quality of fruit; Seed production technology of varieties and hybrids; Seed collection and extraction in fruit and plantation crops.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Desai BB, Katecha, PM & Salunke DK.1997. *Seed Hand Book: Biology Production, Processing and Storage*. Marcel Dekker.

Desai BB. 2004. *Seeds Handbook*. Marcel Dekker.

Doijode SD. 2001. *Seed Storage of Horticultural Crops*. CBS.

George RAT. 1980. *Vegetable Seed Technology. A Technical Guide to Vegetable Seed Production, Processing, Storage and Quality Control.* FAO, Rome.

Hartman HT & Kester DE. 2000. *Plant Propagation: Principles andPractices*. Prentice Hall.

ICAR. *Hand Book of Horticulture.* ICAR Publ.

Kelly AF & George RAT. (Eds.).1998. *Encyclopedia of Seed Production of World Crops*. John Wiley & Sons.

McDonald MB Jr & Copeland LO. 1997. *Seed Production of Crops:Principles and Practices*.

Chapman & Hall. Salunkhe

DK, Desai BB & Bhat RN. 1987. *Vegetable and Flower SeedProduction*. Agricole Publ. Academy.

Singh SP. 2001. *Seed Production of Commercial Vegetables*.Agrotech.

Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.

SST 506 SEED LEGISLATION AND CERTIFICATION 2+1

Objective

To apprise students with the legislative provisions and processes and the mechanisms of seed quality control.

Theory

UNIT I

Historical development of Seed Industry in India; Seed quality: concept and factors affecting seed quality during different stages of production, processing and handling; seed quality control- concept and objectives; Central Seed Certification Board (CSCB).

UNIT II

Regulatory mechanisms of seed quality control- organizations involved in seed quality control programmes; seed legislation and seed law enforcement as a mechanism of seed quality control; the Seed Act (1966), Seed Rules (1968), Seed (Control) Order 1983; Essential Commodities Act (1955); Packaging commodities order (1955); The standards of weights and measurements Act (1976); Plants, Fruits and Seeds Order (1989); National Seed Development Policy (1988) and EXIM Policy regarding seeds, plant materials; New Seed Bill-2004 etc. Introduction, objectives and relevance of plant quarantine, regulations and plant quarantine set up in India.

UNIT III

Seed Certification- history, concept and objectives of seed certification; seed certification agency/organization and staff requirement; legal status and phases of seed certification; formulation, revision and publication of seed certification standards; Indian Minimum Seed Certification Standards (I.M.S.C.S.)- general and specific crop standards including GM varieties, field and seed standards; planning and management of seed certification programmes- eligibility of a variety for certification, area assessment, cropping history of the seed field, multiplication system based on limited generation concept, isolation and land requirements etc.

UNIT IV

Field Inspection- principles, phases and procedures; reporting and evaluation of observations; pre and post-harvest control tests for genetic purity evaluation (grow-out tests); post harvest inspection and evaluation; seed sampling, testing, labeling, sealing and grant of certificate; types and specifications for tags and labels; maintenance and issuance of certification records and reports; certification fee and other service charges; training and liaison with seed growers. OECD seed certification schemes.

UNIT V

Introduction to WTO and IPRs; Plant Variety Protection and its significance; UPOV and its role; DUS testing- principles and applications; essential features of PPV & FR Act, 2001 and related Acts.

Practical

General procedure of seed certification; Identification of weed and other crop seeds as per specific crops; Field inspection at different stages of a crop and observations recorded on contaminants and reporting of results; Inspection and sampling at harvesting/threshing,

Processing and after processing for seed law enforcement; Testing physical purity, Germination and moisture; Specifications for tags and labels to be used for certification purpose; Grow-out tests for pre and post-harvest quality control; Visits to regulatory seed testing laboratory, Including plant quarantine lab and seed certification agency.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. Oxford & IBH.

Anonymous 1992. *Legislation on Seeds*. NSC Ltd., Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi.

Nema NP. 1986. *Principles of Seed Certification and Testing*. Allied Publs.

Ramamoorthy K, Sivasubramaniam K and Th.A. Kannan 2006. *Seed Legislation in India.* Agrobios, Jodhpur.

Tunwar NS & Singh SN. 1988. *Indian Minimum Seed Certification Standards*. CSCB, Ministry of Agriculture, New Delhi.

SST 507 SEED PROCESSING AND STORAGE 2+1

Objective

To impart knowledge on the principles and techniques of seed processing for quality upgradation and of storage for maintenance of seed quality.

Theory

UNIT I

Introduction: Principles of seed processing; methods of seed drying including dehumidification and its impact on seed quality. Relative humidity and equilibrium moisture content of seed; Thumb rules of seed storage; loss of viability in important agricultural and horticultural crops, viability equations and application of nomograph.

UNIT II

Seed cleaning equipment and their functions: Preparing seed for processing; functions of scalper debearder, scarifier, huller, seed cleaner and grader. Screen cleaners, specific gravity separator, indented cylinder, velvet-spiral-disc separators, colour sorter, delinting machines; seed blending.

UNIT III

Assembly line of processing and storage, receiving, elevating and conveying equipments, plant design and layout, requirements and economic feasibility of seed processing plant.

UNIT IV

Seed treatments-methods of seed treatment, seed treating formulations and equipments, seed disinfestations, identification of treated seeds; Packaging: principles, practices and materials; bagging and labeling.

UNIT V

Seed storage: Seed drying and storage; drying methods-importance and factors affecting it, changes during storage, concepts and significance of moisture equilibrium, methods of

maintaining safe seed moisture content. Methods to minimize the loss of seed vigour and viability; factors influencing storage losses. Storage methods and godown sanitation. Storage structures- Designing of seed storage structures, Storage problems of recalcitrant seeds and their conservation.

Practical

Operation and handling of mechanical drying equipments; Effect of drying temperature and duration on seed germination and storability with particular reference to oil seeds; Seed extraction methods; Seed processing equipments; Seed treating equipments; Visit to seed processing plant and commercial controlled and uncontrolled Seed Stores;. Seed quality upgradation; Measurement of processing efficiency; Seed blending, Bag closures; Study of orthodox, Intermediary and recalcitrant seeds; Evaluating seed viability at different RH and temperature levels and packaging materials; Prediction of storability by accelerated ageing controlled deterioration tests.

Suggested Readings

Agrawal RL. 1996. *Seed Technology*. Oxford Publ.

Barton LV. 1985. *Seed Preservation and Longevity*. International Books and Periodicals Supply Service, New Delhi.

Hall CW. 1966. *Drying of Farms Crops*. Lyall Book Depot.

Justice OL & Bass LN. 1978. *Principles and Practices of Seed Storage*. Castle House Publ. Ltd.

Mathews RK, Welch GB, Delouche JC & Dougherty GM. 1969. *Drying, Processing and Storage of Corn seed in Tropical and Subtropical Regions*. Proc. Am. Agric. Eng. St. Joseph, Mich. Paper No. 69-67.

Sahay KM & Singh K.K. 1991. Unit Operations in Food Engineering. Vikas Publ.

Virdi SS & Gregg BG. 1970. *Principles of Seed Processing*. National Seed Corp., New Delhi.

SST 508 SEED QUALITY TESTING 2+1

Objective

To provide a comprehensive knowledge on all aspects of seed quality evaluation and their relevance to crop performance.

Theory

UNIT I

Introduction: Structure of monocot and dicot seeds; seed quality: objectives, concept and components and their role in seed quality control; instruments, devices and tools used in seed testing. National and international organizations in seed testing; ISTA and its role in seed testing.

UNIT II

Seed Sampling: definition, objectives, seed-lot and its size; types of samples; sampling devices; procedure of seed sampling; sampling intensity; methods of preparing composite and submitted samples; sub-sampling techniques, dispatch, receipt and registration of submitted sample in the laboratory, sampling in the seed testing laboratory.

UNIT III

Physical Purity: definition, objective and procedure, weight of working samples for physical purity analysis; components of purity analysis and their definitions and criteria; pure seed definitions applicable to specific genera and families; multiple seed units; general procedure of purity analysis; calculation and reporting of results, prescribed seed purity standards; determination of huskless seeds; determination of weed seed and other seed by number per kilogram; determination of other distinguishable varieties (ODV); determination of test weight and application of heterogeneity test.

UNIT IV

Seed moisture content: importance of moisture content; equilibrium moisture content; principles and methods of moisture estimation - types, instruments and devices used; pre-drying and grinding requirements, procedural steps in moisture estimation; calculation and reporting of results.

UNIT V

Germination: importance; definitions; requirements for germination, instrument and substrata required; principle and methods of seed germination testing; working sample and choice of method; general procedure for each type of method; duration of test; seedling evaluation; calculation and reporting of results; dormancy: definition, importance, causal mechanisms, types and methods for breaking dormancy.

UNIT VI

Viability and Vigour Testing: definition and importance of viability tests-different viability tests; quick viability test (TZ- test) - advantages, principle, preparation of seeds and solutions, procedure, evaluation and calculation of test results. Vigour testing: concept, historical development, definitions, principles and procedures of different methods used for testing vigour.

UNIT VII

Genetic purity testing : objective and criteria for genetic purity testing; types of test-laboratory, Growth Chamber and field testing based on seed , seedling and mature plant morphology; principles and procedures of chemical, biochemical and molecular tests.

UNIT VIII

Seed health Testing: field and seed standards; designated diseases, objectionable weeds - significance of seed borne disease vis-a-vis seed quality - seed health testing and detection methods for seed borne fungi, bacteria, viruses and nematodes. Important storage pests, their identification, monitoring and detection.

UNIT VIII

Testing of pelleted and coated seeds; Testing of GM seeds and trait purity, load of detection (LOD).

UNIT X

Preparation and dispatch of seed testing reports; storage of guard samples; application and use of seed standards and tolerances.

Practical

Structure of monocot and dicot seeds of important plant species; Identification and handling of instruments used in seed testing laboratory; Identification of seeds of weeds and crops; Physical purity analysis of samples of different crops; Estimation of seed moisture content (oven method);

Seed dormancy breaking methods requirements for conducting germination test, Specifications and proper use of different substrata for germination; Seed germination testing in different agri-horticultural crops; seedling evaluation; Viability testing by tetrazolium test in different crops; Seed and seedling vigour tests applicable in various crops; Species & cultivar identification; Genetic purity testing by chemical, Biochemical and molecular methods; Seed health testing for designated diseases, Blotter methods, Agar method and embryo count methods; Pest damage evaluation; Testing coated/pelleted seeds.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. Oxford & IBH.

Agrawal PK & Dadlani M.1992. *Techniques in Seed Science and Technology*. 2nd Ed. South Asian Publ.

Agrawal PK. (Ed.). 1993. *Handbook of Seed Testing*. Ministry of Agriculture, GOI, New Delhi.

Copland LO & McDonald MB. 1996*. Principles of Seed Science and Technology*.

Kluwer. ISTA 2006. *Seed Testing Manual*. ISTA, Switzerland.

Karuna V. 2007 *Seed Health Testing* Kalyani.

Martin C & Barkley D. 1961. *Seed Identification Manual*. Oxford & IBH.

Tunwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Ministry of Agriculture, New Delhi.

SST 509 SEED PHYSIOLOGY 2+1

Objective

To provide an insight into physiological processes governing seed quality and its survival.

Theory

UNIT I

Physiology of seed development and maturation; chemical composition, synthesis and accumulation of seed reserves, induction of desiccation tolerance, hormonal regulation of seed development.

UNIT II

Seed germination; factors affecting germination-role of embryonic axis; growth hormones and enzyme activities, effect of age, size and position of seed on germination. Physiological processes during seed germination; seed respiration, breakdown of stored reserves in seeds, mobilization and interconversion pathways. Seed dormancy- types, significance, mechanism, endogenous and exogenous factors regulating dormancy, role of phytochrome and PGR, genetic control of dormancy.

UNIT III

Seed viability and longevity, pre and post-harvest factors affecting seed viability; seed ageing; physiology of seed deterioration ; lipid peroxidation and other viability theories; means to prolong seed viability; mechanism of desiccation sensitivity and recalcitrance with respect to seed longevity.

UNIT IV

Seed vigour and its concept, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield. Seed invigoration and its physiological and molecular control.

Practical

Proximate analysis of chemical composition of seed; Methods of testing viability; kinetics of seed imbibition and solute leakage; seed germination and dormancy breaking methods; seed invigoration and priming treatments; accelerated ageing and controlled deterioration tests; enzymatic activities and respiration during germination and effect of accelerated ageing; vigour testing methods etc.

Suggested Readings

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

Baskin CC & Baskin JM. 1998. *Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination*. Academic Press.

Basra AS. 2006. *Handbook of Seed Science and Technology*. Food Product Press.

Bench ALR & Sanchez RA. 2004. *Handbook of Seed Physiology*. Food Product Press.

Bewley JD & Black M. 1982. *Physiology and Biochemistry of Seeds in Relation to germination*. Vols. I, II. Springer Verlag.

Bewley JD & Black M. 1985. *Seed: Physiology of Seed Development and Germination*. Plenum Press.

Copeland LO & Mc Donald MB. 1995. *Principles of Seed Science and Technology*. 3rd Ed. Chapman & Hall.

Khan AA. 1977. *Physiology and Biochemistry of Seed Dormancy and Germination*. North Holland Co.

Kigel J & Galili G. (Eds.). *Seed Development and Germination*.

Marcel Dekker. Murray DR. 1984. *Seed Physiology.* Vols. I, II. Academic Press.

Sadasivam S & Manickam A. 1996. *Biochemical Methods*. 2nd Ed. New Age.

SST 510 SEED PATHOLOGY 2+1

Objective

To acquaint the students with principles and practices of seed health testing and management of seed borne diseases.

Theory

UNIT I

History and economic importance of seed pathology in seed industry and plant quarantine; terminology, important seed transmitted pathogens; seed microbes and their mode of action, detection techniques and identification of common seed borne pathogens.

UNIT II

Morphology and anatomy of typical monocotyledonous and dicotyledonous seeds; mode and mechanism of transmission of seed borne pathogens and microorganisms. Rate of transmission of major plant pathogens, microorganisms in relation to seed certification and tolerance limit; type of losses caused by seed- borne diseases.

UNIT III

Role of microorganisms in seed quality deterioration; management of seedborne plant pathogens/diseases and procedure for healthy seed production; different seed health testing methods for detecting microorganisms; Special detection methods of seed pathogen- histo pathological studies of seed borne pathogens; treatments to control seed borne diseases.

UNIT IV

Pest Risk Analysis (PRA) and disease free seed production, Sanitary & Phytosanitory (SPS) requirements in seed trade, International regulation (ISHI) in respect of seed health standards. Objectionable seed borne diseases.

Practical

Different methods of examination of seeds to assess seed-borne microorganisms and to quantify infection percentage, Detection of seed borne fungi, Bacteria and viruses, Identification of storage fungi, Control of seed borne diseases, Seed treatment methods.

Suggested Readings

Agarwal VK & Sinclair JB. 1997. *Principles of Seed Pathology*. Boca Raton.

Karuna V. 2007. *Seed Health Testing*. Kalyani.

Mathur SB and Kn Mortensen 1997. Seed health testing in the production of Quality seeds. ISTA. Zurich.

Neergaard P. 1988. *Seed Pathology*. Mac Millan.

SST 511 SEED ENTOMOLOGY 2+1

Objective

To apprise about the role of insects in seed production and their effect on seed quality during storage.

Theory

UNIT I

Principles of seed entomology; pollinator insects, insect pests and their classification based on mode of infestation etc.

UNIT II

Principles of insect pollination, role of pollinators in seed production. Augmenting quality seed production through honeybee pollination in crucifers and forage legumes. Plant protection measures in bee pollinated crops. Management of pollinators for hybrid seed production.

UNIT III

Major insect pests of principal crops and their management practices. Methods of insect pest control. Classes of pesticides, their handling and safe use on seed crops.

UNIT IV

Storage insect pests infecting seeds, their development and economic importance. Storage losses due to pests, control of storage pests, Management of storage insects pests, mites and rodents, seed sampling and loss estimation.

UNIT V

Principles of fumigation and their use, effect of different fumigants; preservatives and seed protectants on seed quality; Type of storage structures – domestic and commercial.

Practical

Collection and identification of insect-pollinators, collection and identification of important pests of stored seeds. Detection and estimation of pest infestation vis- a- vis loss of seed quality. Safe handing and use of fumigants and insecticides; Safety measures in fumigating and disinfecting , Exposure period, aeration etc. the storage structures. Plant protection equipments, their operation and maintenance. Pesticides, its dose determination, Preparation of solution and its application.

Suggested Readings

Agarwal NA & Girish GK. 1977. *An Introduction to Action Programme to Regress on Farm Storage Losses in India*. FAO/NORAD Seminar on Farm Storage Grain in India, Nov. 29-Dec. 8, 1977.

Anderson JA & Aleock AW. 1954. *Storage of Cereal Grain & their Products*. American Assoc.
Cereal Chemists, St. Pauls, Minn.

Cottong RT. 1963. *Insect Pests of Stored Grain and Grain Products*. Burgess Publ. Co., Minneopolis, Minn., USA.

Monro 1969. *Manual of Fumigation for Insect Control*. FAO Rome Agril. Studies No. 79.

Subramanyam B & Hagstrum DW. 1995. *Interrelated Management of Insects in Stored Products*. Marcel Dekker.

SST 512 SEED PRODUCTION IN FORAGE, PASTURE AND GREEN MANURE CROPS 2+1

Objective

To apprise about the basic requirements and methods of quality seed production in forage, pasture and green manure crops.

Theory

UNIT I

Important pasture and forage legume crops in India; seed requirement and production; classification of forage, pastures and green manure crops; pollination behavior.

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 storage, 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.

Suggested Readings

Farity DT & Hampton JC. 1997. *Forage Seed Production*. Vol. I.*Temperate species*. CABI.

Froma J. 1997. *Temperate Forage Legumes*. CABI.

Gutterridge RG. 1997. *Forage Tree Legumes in Tropical Agriculture*.CABI.

Quality Declared Seed System. 2007. FAO Plant Production and Protection Publication No.185: FAO, Rome.

SST 513 SEED STORAGE AND DETERIORATION 1+1

Objective

To provide understanding of the mechanism of seed ageing during storage, factors affecting it and its control.

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; Techniques of handling and storage of recalcitrant seed.

UNIT II

Factors affecting seed storability- biotic and abiotic and pre- and post harvest 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; hysteresis effect; thumb rules; 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, its causes, symptoms, mechanisms and related theories; 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- requirement of storage facilities in India; types and storage structures available in the country 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.

Suggested Readings

Barton LV. 1961. *Seed Preservation and Longevity*. Burgess Publ.

Basra AS. (Ed.). 1995. *Seed Quality: Basic Mechanisms and Agricultural Implications*. Food Products Press.

Basra AS. 2006. *Handbook of Seed Science and Technology*. Food Product Press.

Desai BB. 2007. *Seed Handbook: Biology, Production, Processing andStorage*. Marcel Dekker.

Doijode SD. 2001. *Seed Storage of Horticultural Crops*. CBS.

Justice OL & Bass LN. 1978. *Principles and Practices of Seed Storage*. Castle House Publ.

Kharb RPS & Kharb P. 1977. Biochemical and Cytogenetical Changes During Storage. In: *Seed Technology* (Eds. BS Dahiya & KN Rai): pp. 160-168.

McDonald MB & Roos EE. (Eds.). 1986. *Physiology of Seed Deterioration*. Paper No. 11, Crop Science Society of America, USA.

Roberts EH. 1972. *Viability of Seeds*. Chapman & Hall.

SST 514 SEED MARKETING AND MANAGEMENT 1+1

Objective

To apprise students about the seed supply system, concepts and principles of effective marketing of seed and strengths and weaknesses of the seed sector.

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 policies, 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.

Suggested Readings

Kohls RL & Uhl JN. 1980. *Marketing of Agricultural Products*. MacMillan.

Kundu KK & Suhag KS. 2006. *Teaching Manual on Seed Marketing and Management*. Department of Agricultural Economics CCS HAU Hisar.

Venugopal P. 2004. *State of Indian Farmers: A Millennium Study*. Vol. VIII. *Input Management*. Academic Foundation, Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi.

SST 515 EMERGING TRENDS IN SEED QUALITY ENHANCEMENT 1+1

Objective

To update knowledge on seed quality enhancement technologies and their application.

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 invigoration treatments and seed hardening; 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.

Suggested Readings

Basra AS. (Ed.). 1995. *Seed Quality: Basic Mechanisms and Agricultural Implications*. Food Product Press, NY.

Basra AS. 2006. *Handbook of Seed Science and Technology*. Food Product. Press, NY

Bench ALR & Sanchez RA. 2004. *Handbook of Seed Physiology*. Food Product Press, NY/ London.

Copland LO & Mc Donald MB. 2004. *Seed Science and Technology*. Kluwer Acad.

Kalloo G, Jain SK, Vari AK & Srivastava U. 2006. *Seed: A Global Perspective*. Associated Publishing Company, New Delhi.

Vanangamudi, K et al., 2006 *Advances in seed science and Technology* : (Vol I) Recent Trends in Seed Technology and Management. Agrobios (India), Jodhpur

SST 516 GERMPLASM COLLECTION, EXCHANGE AND QUARANTINE 2+1

Objective

To provide information about collection, germplasm exchange, quarantine, maintenance and use of plant genetic resources including genetically modified plants.

Theory

UNIT I

History and importance of germplasm exploration; Distribution and extent of prevalent genetic diversity; Phyto-geographical regions/ecological zones and associated diversity; Mapping eco-geographic distribution of diversity, threatened habitats, use of flora.

UNIT II

Concept of population and gene pool; Variations in population and their classification; Gene frequencies in populations, rare and common alleles; Gene pool sampling in self

and cross pollinated and vegetatively propagated species; Non-selective, random and selective sampling strategies; Strategies and logistics of plant exploration and collection; Coarse and fine grid surveys; Practical problems in plant exploration; Use of *in vitro* methods in germplasm collection.

UNIT III

Ethnobotanical aspects of PGR; Crop botany, farming systems, collecting wild relatives of crop plants; Collection and preservation of specimens; Importance and use of herbaria and preparation of herbarium specimens.

UNIT IV

Post-exploration handling of germplasm collections; Present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, *Brassica*, okra, eggplant, cotton, mango etc; approaches for collection including indigenous knowledge.

UNIT V

History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange; Documentation and information management; Plant quarantine- introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India; Pest risk analysis, pest and pathogen information database; Quarantine in relation to integrated pest management; Economic significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma etc.).

UNIT VI

Detection and identification of pests including use of recent techniques like ELISA, PCR etc., Symptoms of pest damage, salvaging techniques for infested/infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities; Domestic quarantine; seed certification; International linkages in plant quarantine; weaknesses and future thrust.

UNIT VII

Genetically modified organisms (GMOs) or genetically engineered plants (GEPs), Concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment; Treaties and multilateral agreements governing trans-boundary movement of GEPs or GMOs, Indian regulatory system for biosafety.

Practical

Plant exploration and collection; Techniques of coarse and fine grid surveys; Identification of wild relatives of crop plants- Example of collection, Cataloguing and preservation of specimens; Sampling techniques of plant materials; Visiting ports, Airports to study the quarantine regulations; Techniques for the detection of insects, Mites, Nematodes, Bacteria, Weeds, Pathogens and viruses on seed and planting materials and salvaging; Use of visual, Qualitative, Quantitative, Microscopic, Molecular and plant growth related techniques (controlled green houses/growth chambers, etc); Detection of GMOs and GEPs; Study of post-entry quarantine operation, Seed treatment and other prophylactic treatments.

Suggested Readings

Briggs D. 1997. *Plant Variation and Evolution*. Science Publ. Cronquist AJ. 1981. *An Integrated System of Classification of Flowering Plants*. Columbia Univ. Press.

Dhillon BS, Varaprasad KS, Kalyani S, Singh M, Archak S, Srivastava U & Sharma GD. 2001.

Germplasm Conservation A Compendium of Achievements. NBPGR, New Delhi.

di Castri F & Younes T. 1996. *Biodiversity Science and Development: Towards New Partnership*. CABI & International Union for Biol. Sci. France.

Gurcharan Singh. 2004. *Plant Systematics: An Integrated Approach*. Science Publ.

Lawrence GMH. (Ed.). 1951. *Taxonomy of Vascular Plants*. London.

Paroda RS & Arora RK. 1991. *Plant Genetic Resources Conservation and Management Concepts and Approaches*. IPGRI Regional office for South and South Asia, New Delhi.

Pearson LC. 1995. *The Diversity and Evolution of Plants*. CRC Press.

Singh BP. 1993. *Principles and Procedures of Exchange of Plant Genetic*

Resources Conservation and Management. Indo-US PGR Project Management.

Sivarajan VV. 1991. *Introduction of Principles of Plant Taxonomy*. Science Publ.

Stace CA. Plant Taxonomy and Biosystematics 2nd Ed. Cambridge Univ.Press.

Takhrajan A. 1997. *Diversity and Classification of Flowering Plants*. Columbia Univ. press.

Wiersema JH. 1999. *World Economic Plants: A Standard Reference*.Blanca Leon.

SST 601 HYBRID SEED PRODUCTION 1+ 1

Objective

To provide a comprehensive knowledge and practical exposure to hybrid seed production in field crops and vegetables.

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, pigeon pea 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 synchrony 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.

Suggested Readings

Basra AS. 2000. *Heterosis and Hybrid Seed Production in Agricultural Crops*. Food Product Press.

McDonald MB & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.

Singhal NC. 2003. *Hybrid Seed Production*. Kalyani Publishers.

SST 602 *IN SITU* AND *EX SITU* CONSERVATION OF GERMPLASM 2+1

Objective

To impart knowledge on the methods of germplasm conservation.

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 sending seeds 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, micro propagation techniques, problems, prospects of *in vitro* gene bank.

UNIT IV

Cryopreservation- procedure for handling seeds of orthodox and recalcitrants- cryoprotectants, dessication, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of

cryopreservation in agriculture, horticulture and forestry crops. Problems and prospects; challenges ahead.

Practical

In situ conservation of wild species –case studies at national and international levels- *ex situ* techniques for active and long-term conservation of collections- Preparation and handling of materials, Packaging, Documentation; Design of cold storage modules- Conservation protocols for recalcitrant and orthodox seeds; Cytological studies for assessing genetic stability, *in vitro* cultures- embryo, Cell/suspension cultures, Pollen cultures, Study of cryotank facility and vitrification techniques, Visit to NBPGR/NBAGR -study using fruit crops and other horticultural crops.

Suggested Readings

Ellis RH & Roberts EH & 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 & Hawkes JG. 1975. *Crop Genetic Resources for Today andTomorrow*. Cambridge University Press, Cambridge.

Simmonds, N.W. 1979. *Principles of Crop Improvement* Longman.

Westwood MN. 1986. *Operation Manual for National Clonal Germplasm Repository Processed Report*. USDA-ARS and Orgon State Univ. Oregon, USA.

Withers LA. 1980. *Tissue Culture Storage for Genetic Conservation*. IBPGR Tech. Rep. IBPGR, Rome, Italy.

SST 603 TESTING FOR GENUINENESS AND PURITY OF CULTIVARS 1+1

Objective

To provide hands-on training on various field and laboratory methods of testing cultivar purity.

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, peroxidase test, auxin 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

Study of morphological characteristic features for varietal identification in major field and vegetable crops, Chemical and biochemical tests for species and cultivar purity: phenol test, seed and seedling tests, electrophoretic analysis of seed protein and isozymes, DNA fingerprinting using PCR techniques, use of chromatography for analysis of secondary compounds. Visit to GOT farms and DNA Finger Printing Labs.

Suggested Readings

Basra AS. (Ed.). 1995. *Seed Quality: Basic Mechanisms and Agricultural Implications*. Food Product Press.

ISTA 2006. *Handbook of Variety Testing*. International Seed Testing Association, Switzerland.

SST 604 DUS TESTING FOR PLANT VARIETY PROTECTION 2+1

Objective

To provide a comprehensive understanding of DUS testing, its conduct and significance to PVP.

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 Tariff and Trades (GATT) agreement in relation to protection of plant varieties; Protection of Plant Varieties and Farmers' Rights (PPV &FR) 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 PVP on growth of seed industry; practical exercise of 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.

Suggested Readings

Chakrabarty SK, Prakash S, Sharma SP & Dadlani M. 2007. *Testing Of Distinctiveness, Uniformity And Stability For Plant Variety Protection*. IARI, New Delhi.

Joshi AK & Singh BD. 2004. *Seed Science And Technology*. Kalyani.

The Protection Of Plant Varieties And Farmers' Rights Act 2001. Bare Act With Short Notes
2006. Universal Law Publ.

SST 605 ADVANCES IN SEED SCIENCE RESEARCH 1+0

Objective

To provide knowledge on the advances in various aspects of seed science & their application in seed technology.

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 PVP internationally.

Suggested Readings

Bench ALR & Sanchez RA. 2004. *Handbook of Seed Physiology*. Food Product Press.

Black M & Bewley JD. (Eds.). 2000. *Seed Technology and its Biological Basis*. Sheffield Academic Press.

Nicolas G, Bradford KJ, Come D & Pritchard HW. 2003. *The Biology of Seeds, Recent Research Advances*. CABI.

List of Journals

Crop Science

Hort. Science

Acta Hoticulturae

Indian Journal of Agricultural Science.

Journal of Seed Technology

Plant Varieties and Seeds

Seed Abstracts

Seed Research

Seed Science & Technology

Seed Science Research

New Seed Journal

Journal of Seed Production

ISST News Bulletin

e-Resources

Ag Biotech Reporter www.bioreporter.com

Agricultural Research Magazine *www.ars.usda.gov/is/AR/*

American Seed Trade Association www.amseed.com

Association of Official Seed Certifying Agencies www.AOSCA.org

Association of Official Seed Analysts www.aosaseed.com

Commercial Seed Analysts Association of Canada www.seedanalysts.com

Front Range Seed Analysts www.frsa.org International

Seed Federation www.wordseed.org International Seed

Testing Association www.seedtest.org

International Society for Seed Science www.css.comell.edu/ISSS/isss.htm

International Society of Seed Technologists www.isstech.org

The Seed Biology web page at Cornell University

www.css.comell.edu/seedbio/seedbio.html

Seed Biology at the Laboratory of Plant Physiology at the Wageningen University

www.wau.nl/uk/organisation

The Ohio State Seed Biology webpage www.css.ohio-state.edu/%7Eseebio/

The Seed Biotechnology Center University of California

http://sbc.ucdavis.edul Seed Viability and Storage Research Unit

www.arsgrain. gov/ars/NoPlains/FtCollins/preservation.htm

Seed World www.seedworld.com

Seed Quest www.seedquest.com

Seed Today www.seedtoday.com/info/ST sites.html

The South African National Seed Organization www.sansor.org/index.htm

Society of Commercial Seed Technologists www.seedtechnology.net

Wageningen Seed Centre www.seedcentre.nl

Suggested Broad Areas for Master's and Doctoral Research

Isolation distance requirements in view of GM varieties
Review of seed certification standards
GOT –seasonal requirements
Genetic purity vis-a-vis trait purity
Enhancement of pollen viability, stigma receptivity and seed setting
Reduction of processing losses
Alternate areas / protected cultivation methods for hybrid seed production
Standardising processing needs in high value crops and forage grasses
Protein and oil content in GM cotton seed and its effect on longevity
Optimisation of hybrid seed production technology in field crops, vegetables and flowers
Pollen collection methods and viability testing
Management of seed borne diseases with biocontrol agents
Seed enhancement for unfavorable conditions
Identification of markers for hybrid confirmation and genetic purity testing
GM seed testing
Seed testing protocols and seed standards for forage crops, medicinal species and spices
Molecular control of seed viability, vigour and invigoration
Standardisation of priming, coating and pelleting technologies
Development of technologies for maintenance of parental lines of SI and MS based hybrids
Any other location specific problems