GROUP-21

Seed Certification Officer (Level- M.Sc. Seed Technology)

1) General awareness, Reasoning, Mathematics, Science, History including Haryana related history, current affairs, literature, Geography, Civics, Environment, Culture etc.- (**Weightage 20%)**

2) Computer terminology, Fundamentals, word software, excel software, Power point, internet, web browsing, Communication, emails, downloading and uploading data on websites etc**. -**

(Weightage 10%)

3) Subject related syllabus- **(Weightage 70%)**

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1. FLORAL BIOLOGY, SEED DEVELOPMENT AND MATURATION

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.

Fertilization, Embryogenesis, Apomixis.

2. SEED PRODUCTION: PRINCIPLES AND PRACTICE

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,maintenance and factors responsible for deterioration; seed production in self- and cross-pollinated crops, 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, rouging etc. male sterility and incompatibility system in hybrid seed production, role of pollinators and their management, seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, agronomy of seed production – agroclimatic requirements and their influence on quality seed production; generation system of seed multiplication; maintenanceof 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, cross pollinated and vegetative propagated crops, 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, Planning of seed production for different classes of seeds for self and cross-pollinated crops, Seed quality control system and organization, seed village concept; Seed production agencies, seed industry and custom seed production in India.

3. GENETICS AND PLANT BREEDING

Mendel's laws and modification of F2 ratios; lethality, segregation distortion; penetranceand expressivity; pleiotropic genes; forward and reverse genetics; Detection of linkage; crossing over and linkage maps three-point test cross, interference, and coincidence; Multiple alleles: concept of multiple alleles; self-incompatibility alleles in Nicotiana, Quantitative inheritance: multiple factor hypothesis; concepts of poly gene effects (additive, dominance, over dominance and epistasis); Sex determination and differentiation: theories of sex determination- genic balance theory; sex determination in dioecious plants (Melandrium, Coccinia, Rumex), Extra chromosomal inheritance: Mutations: brief history of mutations; physical and chemical mutagenesis; Concept of gene: classical and modern gene concepts; pseudoallelism, position effect; intragenic crossing over and complementation (cistron, recon and muton); Introduction and application of transgenics, Breeding methods for self–pollinated crops; mass selection; pure line selection; pedigree, selection; Bulk method; Backcross method. Breeding methods of cross- pollinated crops; GCA, SCA, RRS. Breeding methods for vegetative propagated crops, Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding, and residual heterosis in F2 and segregating populations, importance of inbreeding inexploitation of heterosis – case studies. - Relationship between genetic distance and expression of heterosis, Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of self-incompatibility in development of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreeds and parental lines- A, B and R lines – functional male sterility;

Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids. Male sterile line creation and diversification in self-pollinated, cross pollinated and asexually propagated crops; problemsand prospects; Apomixis in fixing heterosis-concept of single line hybrid.

4. PHYSIOLOGY OF SEED

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

5. SEED PROCESSING, STORAGE AND DETERIORATION

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 andhorticultural crops, viability equations and application of nomograph, 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, Assembly line of processing and storage, receiving, elevating and conveying equipment,plant design and layout, requirements and economic feasibility of seed processing plant, Seed treatments-methods of seed treatment, seed treating formulations and equipment, seed disinfestations, identification of treated seeds; Packaging: principles, practices and materials; bagging and labelling, Seed storage: Seed drying and storage; drying methods-importance and factors affecting it, changes during storage, concepts and significance of moisture equilibrium, methods ofmaintaining safe seed moisture content. Methods to minimize the loss of seed vigour and viability; factors influencing storage losses. Storage methods and go-down sanitation, Storage structures. Storage problems of recalcitrant seeds and their conservation, 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

6. PRINCIPLES AND TECHNIQUES IN VEGETABLE SEED PRODUCTION

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 behaviour; steps in quality seed production; identification of suitable areas/locations for seed production of these crops, Classification based on growth cycle and pollination behaviour; 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, 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, 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.

7. SEED LEGISLATION AND CERTIFICATION

Historical development of Seed Industry in India; Seed quality: concept and factors affecting seed quality during different stages of production, processing and handling; seed qualitycontrol- concept and objectives; Central Seed Certification Board (CSCB), Regulatory mechanisms of seed quality control-organizations involved in seed qualitycontrol 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); 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 andplant quarantine set up in India, 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, Field Inspection- principles, phases and procedures; reporting and evaluation of observations; pre and post-harvest control tests for genetic purity evaluation (grow-outtests); post-harvest inspection and evaluation; seed sampling, testing, labelling, 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, 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.

8. SEED QUALITY TESTING

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. ISTA and its role in seed testing, Seed Sampling: definition, objectives, seed-lot and its size; types of samples; sampling, devices; procedure of seed sampling; sampling intensity; methods of preparing compositeand submitted samples; sub-sampling techniques, dispatch, receipt and registration of submitted sample in the laboratory, sampling in the seed testing laboratory, 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 procedureof 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, Seed moisture content: importance of moisture content; equilibrium moisture content; principles and methods of moisture estimation - types, instruments and devices used; predrying and grinding requirements, procedural steps in moisture estimation; calculation and reporting of results, Germination: importance; definitions; requirements for germination, instrument and substrata required; principle and methods of seed germination testing; working sample andchoice 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, 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, Genetic purity testing: objective and criteria for genetic purity testing; types of tests;laboratory, Growth Chamber and field testing based on seed, seedling and mature plant morphology; principles and procedures of chemical, biochemical and molecular tests, 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 detectionmethods for seed borne fungi, bacteria, viruses and nematodes, Testing of GM seeds and trait purity, load of detection (LOD), Preparation and dispatch of seed testing reports; storage of guard samples; application and use of seed standards and tolerances.

9. SEED HEALTH TECHNOLOGYAND QUARANTINE

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, Morphology and anatomy of typical monocotyledonous and dicotyledonous seeds; modeand 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, Role of microorganisms in seed quality deterioration; management of seed borne plant pathogens/diseases and procedure for healthy seed production; different seed health testingmethods for detecting microorganisms; treatments to control seed borne diseases, Pest Risk Analysis (PRA) and disease free seed production, Sanitary &Phytosanitary (SPS), requirements in seed trade, international regulation (ISHI) in respect of seed health standards. Problems in assessing the overall effectiveness of plant quarantine; techniques for the detection of insects/mites, nematodes, fungal and bacterial pathogens, viruses and salvaging of infested / infected germplasm.

10. SEED MARKETING AND MANAGEMENT

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, 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, Seed marketing intelligence and product mix, sales promotion, distribution channels, marketing costs and margins, Salient features of national seed policies, role of various sectors/agencies in efficient seed marketing, quality control and assurance programme. Responsibilities of seed companiesand dealers under Seed Act, EXIM policies for seed trade etc.

11. SEED BIOTECHNOLOGY

Introduction and brief history of biotechnology, Scope of biotechnology inconservation of quality seeds and their improvement. Tools and techniques of Tissue culture. Different culture methods and regeneration protocols for plants, media for invitro culture - minerals, vitamins, and natural adjuvant like coconut milk, auxins, cytokinin’s, antioxidants and other growth regulators. Solid and liquid media, Commercial prepacked media. Design of laboratory and commercial tissue culture facility, Procedures in Tissue Culture: Preparation of media. Plant hormones and their role in development, Fumigation, wet and dry sterilization, ultraviolet sterilization, ultra-filtration and surface sterilization. Laminar flow hood. Maintenance of axeniccultures. Explants for Tissue Culture: Totipotency, Shoot tip, axillary buds, leaf discs, cotyledons, inflorescence and floral organs. Callus culture - initiation andmaintenance of callus. Direct and indirect organogenesis and embryogenesis, callogenesis, somatic embryogenesis, acclimatization. Soma clonal variation and its application for plant improvement, Problems encountered in genetic conservation, production of haploids, embryo culture and embryo rescue technique, Anther and pollen culture production of Di-haploids and their utility. Protoplast culture, isolation, fusion technique and their utility, regeneration of hybrid plants, symmetric and asymmetric hybrids, Cybrids, Cryopreservation of seed, plant material and callus-principles and techniques, in vitro flowering and production and maintenance of disease-free clones through tissueculture, Cellular and molecular gene banks. Preservation of nonviable seeds. Production, storage and use of artificial or synthetic seeds. Genetic purity analysis of seeds. Application of different techniques, viz; identification of marker proteins, isozyme analysis. Introduction of RFLP and RAPD techniques and their applicability.

12. BASIC CONCEPTS IN LABORATORY TECHNIQUES

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Electric wiring and earthing. Preparation of solutions of acids; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values. Preparation of media and methods of sterilization.

13. GERMPLASM COLLECTION, EXCHANGE AND QUARANTINE

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, 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 andfine grid surveys; Practical problems in plant exploration; Use of in vitro methods in germplasm collection, 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, Post-exploration handling of germplasm collections; Present status and future strategies incollection of major crops of Indian origin such as rice, maize, sorghum, sesame, Brassica, okra, eggplant, cotton, mango etc; approaches for collection including indigenous knowledge, History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collectionand 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.), Detection and identification of pests including use of recent techniques like ELISA, PCRetc., Symptoms of pest damage, salvaging techniques for infested/infected germplasm, postentry quarantine operation, seed treatment and other prophylactic treatments and facilities; Domestic quarantine; seed certification; International linkages in plant quarantine; weaknesses and future thrust, 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

14. SEED PRODUCTION IN FIELD CROPS

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.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-crosspollinated cereals and millets, Floral structure, breeding and pollination mechanism; methods and techniques of seedproduction in pulses (pigeon pea, chick pea, green gram, black gram, beans, peas etc.), Floral structure, breeding and pollination mechanism; methods and techniques of seed production in major oil seeds (groundnut, castor, sunflower, rape and mustard, linseed, sesame etc.), Floral structure, breeding and pollination mechanism; methods and techniques of seed production in vegetatively propagated crops like zinger, potato and turmeric etc.

15. EMERGING TRENDS IN SEED QUALITY ENHANCEMENT

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, Seed priming: physiological and biochemical basis, types of priming technology, biochemical and molecular changes associated, pre-germination, film coating and pelleting, seed tapes, seed mats, seed colouring, biopriming, Synthetic seeds – Aim and scope for synthetic seeds, historical development, somatic embryogenesis, soma-clonal 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.

16. DUS TESTING FOR PLANT VARIETY PROTECTION

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, 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, 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.

17. HYBRID SEED PRODUCTION

Heterosis: definition, expression and estimation of hybrid vigour; utilization of heterosis in agricultural, horticultural and other crop plants for crop improvement, 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, Techniques of hybrid seed production - emasculation and crossing: use of self-incompatibility, modification of sex; types of male sterility and exploitation in hybriddevelopment and its use in hybrid seed production; development and maintenance of A, B and R lines, 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.

18. SEED ENTOMOLOGY

Principles of seed entomology; pollinator insects, insect pests and their classification based on mode of infestation etc. Principles of insect pollination, role of pollinators in seed Production. Augmenting quality seedproduction through honeybee pollination in crucifers and forage legumes. Plant protectionmeasures in bee pollinated crops. Management of pollinators for hybrid seed production, 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, 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, Principles of fumigation and their use, effect of different fumigants; preservatives and seed protectants on seed quality; Type of storage structures – domestic and commercial.

19. AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels, Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems inresearch ethics, Concept and connotations of rural development, rural development policies and strategies, Rural development programmes: Community Development Programme, IntensiveAgricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Important Note: The Weightage as mentioned against the syllabus is tentative & may vary.