New and Restructured Curriculum & Syllabus

Implemented from Academic Session 2020-2021

Pre-Ph.D. (Seed Science & Technology)

Approved by:

Board of Studies, Seed Science & Technology

School of Agriculture & Allied Science

Hemvati Nandan Bahuguna Garhwal University

(A Central University)

Srinagar Garhwal, Uttarakhand (India)-246 174

www.hnbgu.ac.in

E mail: seedscience.hnbgu@gmail.com

HNB GARHWAL UNIVERSITY (A CENTRAL UNIVERSITY)

SRINAGAR GARHWAL, UTTARAKHAND-246 174

Pre-Ph.D. Course of one Semester (6 MONTHS)
(SEED SCIENCE & TECHNOLOGY)

(Syllabus implemented from Academic session 2020-2021)

ORDINANCES

Admission of the Ph.D. Program in Seed Science & Technology shall be through entrance examination conducted by the University. To get registered in Ph.D programme, a student has to appear in entrance exams conducted by the University, subsequently an interview is conducted. A Successful candidate has to complete a pre-Ph.D course for registration in vacant seat in which Core course of 7 credits and elective course of 8 credits shall be mandatory. The program is based on credit system in which credit defines the quantum of content/ syllabus prescribed for a course system and determines the number of hours of instruction per week.

PRE-Ph.D. COURSE OF ONE SEMESTER

(SEED SCIENCE & TECHNOLOGY)

Course Contents

COURSE CODES	TITLE OF THE COURSE	Total Marks	End Term Tests	Internal		Credits
				Sessional Test (I)	Sessional Test (II)	
SAS/ ST/ C018	**(A)**Research Publication and Ethics **(B)**Seed Health Testing: Principles & Practices	100	60	20	20	(2+1)3
SAS/ST/C019	Research Methodology & Computer Applications	100	60	20	20	**(**4)
Elective Course-I		100	60	20	20	(4)
Elective Course-II		100	60	20	20	(4)
Total		**500**	**300**	**100**	**100**	**15**

Electives Courses for Pre-Ph.D (a student has to study only 2 courses.)

SAS /ST/ E009	Seed Disorders, Allelopathy and Recalcitrance
SAS /ST/ E010	Testing for Genuineness & Purity of Cultivars
SAS /ST/ E011	Seed Production and Cultivation of Medicinal and Aromatic Plants (MAPs)
SAS /ST/ E012	Tree Seed Technology
SAS /ST/E014	Advances in Seed Science Research

SYLLABUS

PRE-Ph.D. COURSE OF ONE SEMESTER (6 MONTHS)

(SEED SCIENCE & TECHNOLOGY)

SAS/ ST/ C018 (A) RESEARCH PUBLICATION AND ETHICS (2)

Objective

To know the basics of philosophy of science and ethics, research integrity and publication ethics.

Theory

Unit-1 Philosophy and Ethics

- Introduction to philosophy: Definition, nature and scope, concept, branches.
- Ethics: Definition, moral philosophy nature of moral judgement and reactions.

Unit-2 Scientific Conduct

- Ethics with respect to Science and research
- Intellectual honesty and research integrity.
- Scientific misconduct: Falsification, fabrication and plagiarism (FFP)
- Redudant publication: duplicate and overlapping publication, salami slicing.
- Selective reporting and misrepresentation of data

Unit-3 Publication Ethics

- Definition, introduction and importance
- Best practices/ standard setting initiatives and guidelines: COPE, WAME etc.
- Conflict of interest
- Publication misconduct: definition, concept problem that lead to unethical behavior and vice-versa type
- Violation of publication ethics, authorship and contributorship
- Identification of publication misconduct, complaints and appeals
- Predatory publisher and journals

Unit-4 Open access publishing

- Open access publishing and initiatives
- SHERPA/RoMEo online resources to check publisher copyright and self archieving policies
- Software tool to identify predatory publication developed by SPPU
- Journal finder/journal suggestion tool viz: JANE, Elsvier journal finder, Springer journal suggester, etc

Unit-5 Publication misconduct

- Group discussion

1. Subject specific ethical issues, FFP, authorship
2. Conflict of interest

3. Complaint and appeal: example and fraud from India and abroad

- Software tool

1. Use of plagiarism software like Turnitin, Urkund and other open source software tool

Unit-6 Database and Research metrics

- Database
  1. Indexing database
  2. Citation database: Web of science , scopus, etc.
- Research metrics
  1. Impact factor of journal as per journal citation report, SNIP, SJR,IPP, cite score
  2. Metrix: h-index, g index, i10 Index, altmetrix

SAS / ST/ C018 (B) Seed Health Testing: Principles & Practices (1)

UNIT-1.

Terminology, Seed health testing; National co-operation, International co-operation ISTA-Seed health committee (ISTA-SHC), International seed health initiatives (ISHI), European & Mediterranean plant protection organization (EPPO), International seed federation (ISF). Seed Industry and Seed Health in India; Seed Industry, Seed health; Teaching, Research,

UNIT-2.

Seed health techniques: examination of Dry Seeds, Seed Soak Test, Standard washing test, Spore identification. Culture Methods: Incubation Methods; Blotter method, 2,4-D blotter, Deep-freeze blotter, Osmotic blotter, Water restriction technique, Selective media, Factors influencing incubation methods, Pre-treatment, Length of incubation period, Amount type and location of inoculum, Humidity, Temperature, Light, Identification and recording of pathogens, Dilution plate method, Fluorescence method, Tissue culture, Conduct metric assays, Vegetative compatibility group analysis, Seeding symptom test; Blotter test, Agar test, Rolled paper towel test, Soil test, Seeding paraquat test, Bell method, Plant growth medium,

UNIT- 3

Histopathological test; Whole seed stain, Seed component, Microtome seed sections, Embryo count method. Nucleic Acid Based Techniques; Restriction fragment length polymorphisms (RFLP) analysis, PCR methods when target nucleotide sequence is known, PCR methods when target nucleotide sequence is limited or unknown, Random amplified polymorphic (RAPD) PCR, Application of PCR, Limitations of PCR, Electrophoresis; starch gel electrophoresis, polyacrylamide gel electrophoresis, Isozyme analysis

Practical:

Seed health testing techniques: visual observation of seeds of various crops, species discoloration, morphological abnormalities and reduced seed size, mixed fruiting structures, use of adhesive tape. Seed soak and washing test: standards seed soak NaOH seed soak, Washing test: standard washing test, filtration test, (CF) extraction test, size selecting sieving, mist extraction system, funnel-spray method. Spore identification: morphological characters, ultrastructural features, viability test (TTC), germination test, Incubation method: blotter method, 2,4,D blotter, deep –freez blotter, Agar plate method, Seedling symptom

test: blotter, agar, rolled paper towel test, seedling paraquat test. histopathological test ,embryo count method, PCR method, electrophoresis: PAGE, isozyme analysis.

Suggested Reading:

L. V. Barton (1985). Seed Preservation and Longevity. International Books and Periodicals Supply Service, New Delhi.

M.S.Bhale, D. Khare, N.D. Raut, & D. Singh. Seed borne diseases objectionable in seed production and their management. Scientific Publ. India

Karuna V. (2007). Seed Health Testing. Kalyani Publishing.

C.L. Mandhar, (1989). Plant Viruses. 2 Vols. Crc. Press, USA.

P. Narayanasamy, 1998. Plant pathogen detection and disease diagnosis. Marcel Deckker, New York.

P. Neergaard (1988). Seed Pathology, (2vols). Mac Millan.

M.M. Prasad, B.K. Singh, & T. Prasad, (2001). Recent trends in disease management. Scientific Publ.

V.K. Agrawal (2006) Seed Health. International Book Distribution Company, Charbagh, Lucknow. ISBN: 81-8189-111-2

SAS/ST/C019 Research Methodology & Computer Applications (4)

Research Design and Data Collection: Research methodology- definition, different types of research design. Basic principles of experimental designs. Sampling design- sample survey, steps in sample design, criteria of selecting a sampling procedure and different types of sample designs. Methods of Data Collection: Primary and secondary

data. Literature collection and citation, bibliography. Writing skills - Preparation of research report, presentations, and writing scientific paper. Impact factor, Citation index, Ethics in research; Plagiarism, ISBN, ISSN.

Processing and Analysis of Data and Sampling: Processing operations, elements/types of analysis, statistics in research, Simple regression and correlation.

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

Analysis of Variance and Covariance: Analysis of Variance and Covariance (basic principles of one-way ANOVA, two-way ANOVA and ANCOVA).

Application of Computer in Research: MS office and its application in Research – MS Word, MS Power point and MS Excel; Basic principles of Statistical Computation using SPSS; Use of Internet in Research – Websites, search Engines, E-journal and E-Library – INFLIBNET.

Practicals

Based on above.

SAS /ST/ E009 Seed Disorders, Allelopathy and Recalcitrance 4(3+1)

UNIT-I.

Disorder and physiological diseases: Damage by cold, history of cold damage. Factors affecting the damage by cold; temperature, control of the damages by cold, storage under controlled atmosphere (CA), causes of the damage by cold, response of abnormal respiration, changes and variations in lipids and fatty acids, permeability of the membrane, sugars and acids, enzymes. Possible mechanisms of damage by cold. Distinct physiological disorder by cold damage; citrus, tomato, burning by the sun, induced desiccation by elevated temperatures. Disorder of storage, onions and other products (damage by ammonia), disorders by chemicals. Disorders by unknown influences (in cotton.).

UNIT-II.

Allelopathy: Introduction, Grummer's Scheme of allelopathy; plant-plant allelopathic relations (cholines), interplant positive allelopathic interactions, plant-microorganisms (phytoncides), microbe-plant allelopathic interactions (marasmins), microb-microbe allelopathic interaction (antibiotics). Chemical characterization of allelopathic agents. Mechanism of action. Physiological mode of action. Modification of soil properties. Allelochemicals-modification of nutrient cycles. Factors controlling allelopathic mechanisms; climate, plant factors, soil factors, biological characteristics, chemical characteristics, rhizophere effect on allelopathy, soil fertility management for the control of allelopathy, uses of allelopathy.

UNIT-III.

Seed recalcitrance, Basis for recalcitrant. Properties of recalcitrant seeds: physical properties, high shedding moisture content and critical moisture content, desiccation sensitivity and drying rate, chilling sensitivity. Collection and extraction of Recalcitrant Seeds: Identification of a candidate tree and phenological studies, harvesting and collection of fruits or seeds, extraction of seeds, grading of seeds, application of wax coating. Transportation, drying. Determination of seed moisture content. Determination of seed germination percent. Humidification of dry seeds; ventilation, temperature, moisture content, organization of nursery, long trips. Dormancy and its effects. Effect of fungal infection.

UNIT-III.

Identification of recalcitrant seed: seed provenance, taxonomic classification and seed storage. Seed morphology, seed moisture content at maturity, identification of seeds using their ability to withstand desiccation, expression of seed moisture content, determination of desiccation tolerance using germination test, genetic association of recalcitrance. Protocols for safe storage of recalcitrant seeds; determination of seed storage environment, determination of optimum air dry storage environment of intermediate species, determination of safe storage period for recalcitrant seeds; viability estimation, chilling sensitivity. Factors that affect interpretation of seed storage behavior; use of immature seeds, seed extraction methods, pretreatment. Drying methods, desiccation, delayed germination tests. Storage of recalcitrant seeds; storage methods, effect of containers, effective methods of storing recalcitrant seeds; moisture of imbibed storage, storage at sub-imbibed condition, partial dehydration, effects of drying, low temperature storage, use of Abscisic acid in seed storage, hydropriming and storage, controlled atmospheric storage, cryopreservation and *invitro* conservation. Preservation as synthetic seeds.

Practical:

Suggested Readings:

R.K. Maiti, N.C. Sarkar and V.P. Singh (2006) Principles of Postharvest Seed Physiology and Technology. Agrobios (India) ISBN: 81-7754-261-3.

K. Sivasubramaniam, K. Raja and R. Geetha (2012) Recalcitrant Seeds: Causes and Effects. Satish Serial Publishing House, Azadpur, Delhi. ISBN: 978-93-81226-00-1

Chakravarty, A. Post Harvest Technology of Cereals, Pulses and Oil Seeds.

SAS / ST/ E010 TESTING FOR GENUINENESS & PURITY OF CULTIVARS 4(3+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, 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, electrophoretic analysis of seed protein and isozymes, DNA fingerprinting using PCR techniques, use of chromatography for analysis of secondary compounds.

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.

SAS / ST/ E011 SEED PRODUCTION AND CULTIVATION OF MEDICINAL AND AROMATIC PLANTS 4 (3+1)

Objective

To impart comprehensive knowledge of seed production in medicinal and aromatic plants with adequate practical training

Theory

UNIT-I

History; Descriptions in Ayurveda, and other Indigenous Systems of Medicine, Floras, Materia Medica, The Wealth of India, Compendiums of MAP's; Classification of MAPs according to botanical and chemical characteristics and uses; Organization related to conservation, domestication, cultivation and financial assistance.

UNIT-II

Processes and consequences in plant introduction, domestication and acclimatization : Gene pool concept, Agro technology and manuring: Soil types, nutrients and soil testing, soil fertility problems and management, nursery techniques, composting, cropping systems, organic farming, protected farming, important institutions engaged in MAP's and development in India and abroad.

UNIT-III

Package of practices of some important MAP's (*Gloriosa superba, Aloe vera, Tinospora cordifolia, Pellargonium graviolense, Asparagus racemosus, Becopa mooneri, Lavender, Citronella, Stevia rebaudiana, Withania somnifera and some high altitude herbs*) under the following heads; Plants description, Distribution, economic importance, active constituents, seed germination/multiplication, yield analysis.

UNIT-IV

Commercial trade in MAP's: marketing, distribution, publicity, import and export, quality control; Work plan for seed production, seed production organizations in world; Varietal verification: modern techniques and applications; Convention on biological diversity(CBD), Convention on International Trade in Endangered Species of wild flora and fauna (CITES),

Practical:

Soil testing: Texture, N, P, K, soil pH, Carbon; Germination test: Effect of light, temperature and growth hormones, Seed polymorphism; Quantitative and qualitative isolation of Protein, Yield analysis: crop and seed; Processing techniques: collection, drying, grading, packing and storage, Vegetative propagation and in-vitro multiplication techniques, Biocomposting and vermicomposting methods

Suggested Readings

555 Medicinal plants, Field and Laboratory Manual: Identification with its phytochemical and in-vitro studies data: Dr. S. Farooq.

M.C. Nautiyal & B.P. Nautiyal, Agro techniques for High Altitude Medicinal and Aromatic Plants: Mahendra Pal and Bishen Singh, Canought place Dehradun

David T. Plummer. An introduction to practical Biochemistry, IIIrd edition, Tata McGraw, Hill Publ. Comp. New Delhi.
S. S. Handa and M. K. Kaul R. R. Jammu. 1996. Cultivation and Utilization of Medicinal Plants: Materia medica, Henry G. Greenish, 1999. Scientific publisher India New Pali Road Jodhpur,
Uniyal, M.R. Medicinal Plants and Minerals of Uttarakhand Himalaya
P. Pushpangadan, S. Mehrotra, A. K. S. Rawat, S. K. Tiwari, R. L. S. Sikarwar and N. Mishra. Package of Practices for Organic Cultivation and Utilization of Important Medicinal Plants (Part-I): Econmic Botany Information Service, National Botanical Research Institute, Lucknow
A.K. Gupta. Quality Standards of Indian Medicinal Plants: Indian Council of Medical Research, New Delhi
Research and Methods in Plant Sciences: Allelopathy- Vol. I, Soil analysis
H. Pathak & S. Kumar. Soil and green house effect. Monitoring and mitigation, CBS Publisher and Distributors, New Delhi.

SAS/ ST/ E012 TREE SEED TECHNOLOGY 4 (3+1)

Objective

To learn about tree seed technology, its germination process, dormancy, seed quality its certification and processing.

Theory

UNIT I

Seed and its importance: Afforestation activity and seed requirements in India; seed problems-Limiting factors in tree propagation and afforestation.

UNIT II

Important Tree Families and Tree bearing Seeds: Floral biology, pollination, fertilization, embryogenesis, Development and maturation of seed bearing organs and seeds in angiosperms and gymnosperms; Seed structure of monocot and dicots, Apomixis, parthenocarpy, polyembryony and somatic embryoids and synthetic seeds. Morphology and anatomy of Fruit and Seed; Chemical composition of seed, seasonality and periodicity of flowering and fruiting; External Factors influencing seed Production; Mass Blooming, Staggered Blooming, Episodic Blooming.

UNIT-IV

Seed dispersal: Definition, purpose, modes – anemochory, zoochory and hydrochory, practical application - pre and post dispersal hazards, seed polymorphism – types, causes, consequences on seedling recruitment, purpose.

UNIT-V

Role of seed technology in nursery stock production: Production of quality seed, identification of seed collection areas, seed orchard- types and seed orchard design; location and maintenance of seed orchards-isolation and roughing, seed source, provenance and stands.

Suggested reading

- Agrawal, P.K. and M. Dadlani. 1987. Techniques in Seed Science and Technology,South Asian Publishers, Delhi.
- Agrawal, R.L. 1996. Seed Technology. Oxford & IBH, Publishing Co., New Delhi.
- Anon. 1965. Field Inspection Manual and Minimum Seed Certification Standards, NSC Publication, New Delhi.
- Faulkner, R.1975. Seed orchard. Forestry Commission Bulletin No.54.149 p.
- Fins, L., Friedman,S.T. and Brotschol (Eds.)Handbook of Quantitative Forest Genetics. Kluwer Academic Press, The Netherlands.
- Khosla, P.K.1981. Advances in forest genetics. Ambika Publisher, New Delhi.375 p.
- Lars Schmidt 2000. Guide to Handling of tropical and sub-tropical forest seeds. Danida Forest Seed Centre, Denmark.
- Mandal, A.K. and Gibson,G.L. (eds) 1997. Forest genetics and tree breeding. CBS Publi. & Distr., New Delhi 268 p.

SAS / ST/ E013 ADVANCES IN SEED SCIENCE RESEARCH 4 (3+ 1)

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 nanotech.

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, A.L.R. and Sanchez, R.A. 2004. *Handbook of Seed Physiology*. Food Product Press.
- Black, M. and Bewley JD. (Eds.). 2000. *Seed Technology and its Biological Basis*. Sheffield

Academic Press.
- Nicolas, G., Bradford, K.J., Come, D. and Pritchard, H.W. 2003. *The Biology of Seeds, Recent Research Advances*. CABI.

SEED SCIENCE AND TECHNOLOGY

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.comelI.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