

**New and Restructured Curriculum & Syllabus**  
*Implemented from Academic Session 2020-2021*



***M.Sc. Ag. (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  
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**HNB GARHWAL UNIVERSITY (A CENTRAL UNIVERSITY)**  
**SRINAGAR GARHWAL, UTTARAKHAND-246 174**  
***DEPARTMENT OF SEED SCIENCE AND TECHNOLOGY***

**MASTER OF SCIENCE (AGRICULTURE)**  
***(SEED SCIENCE & TECHNOLOGY)***

(Syllabus implemented from Academic session 2020-2021)

**ORDINANCES**

Admission of the Master's Program in Seed Science & Technology shall be through entrance examination conducted by the University. 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.

The student shall be eligible for admission to M.Sc (Ag.) program in Seed Science & Technology after he/she has successfully completed a three year undergraduate degree/four year agriculture undergraduate degree or earned prescribed number of credits through the examinations conducted by University as equivalent to an undergraduate degree.

In order to qualify for a two year master's degree, a student must acquire a minimum of 72 credits; 54 credits in Core courses and 18 credits in electives courses with one self study course of minimum 03 credits. A bridge course of minimum 03 credits only for non-agriculture graduates shall be mandatory and shall not be included while calculating grades. The Thesis/dissertation is to be allotted in the beginning of III Semester and would be submitted during the examination of the IV Semester.

There are 17 seats only. B.Sc. (Ag.), B.Sc. in Horticulture, B.Sc. in Forestry, B.Sc. in Seed Technology or B.Sc. degree with Botany as one of the subjects, awarded by a University or Institute incorporated by law and recognized by this University is the minimum qualifications for admission. However, the students coming from biology background i.e. non-agriculture graduates have to pass a bridge course on Introductory Agriculture. The marks obtained in this course are not counted in the final calculation of percentage and award of class.

**H.N.B. Garhwal University, Srinagar (Garhwal) Uttarakhand, India-246 174**  
**Course Curriculum for**  
**M.Sc (Ag.) *Seed Science & Technology***  
**From the academic session- 2020-2021**

**COURSE OFFERED**

<b>Course No.</b>	<b>Course Title</b>	<b>Credits</b>
SAS/ ST/C001	Floral Biology, Seed Development and Maturation	<b>3</b>
SAS/ ST/C002	Seed Production: Principles and Practices	<b>3</b>
SAS/ ST/C003	Genetics and Plant Breeding	<b>3</b>
SAS/ ST/C004	Physiology of Seed	<b>3</b>
SAS/ ST/C005	Seed Processing , Storage and Deterioration	<b>3</b>
SAS/ ST/C006	Laboratory Course - I	<b>3</b>
SAS/ ST/C007	Principles and Techniques in Vegetable Seed production	<b>3</b>
SAS/ ST/C008	Seed Legislation and Certification	<b>3</b>
SAS/ ST/C009	Seed Quality Testing	<b>3</b>
SAS/ ST/C010	Seed Health Technology and Quarantine	<b>3</b>
SAS/ ST/C011	Intellectual Property and its Management in Agriculture	<b>3</b>
SAS/ ST/C012	Laboratory Course - II	<b>3</b>
SAS/ ST/C013	Seed Marketing and Management	<b>3</b>
SAS/ ST/C014	Seed Biotechnology	<b>3</b>
SAS/ ST/C015	Laboratory Course - III	<b>3</b>
SAS/ ST/C016	Master's Research Thesis	<b>6</b>
SAS/ ST/C017	Laboratory Course - IV	<b>3</b>
<b>Total-(A)</b>		<b>54</b>

**Elective Courses**

SAS/ ST/E001	Basic Concept in Lab. Techniques	<b>3</b>
SAS/ ST/E002	Germplasm Collection, Exchange and Quarantine	<b>3</b>
SOA/ ST/E003	Seed Production in Field Crops	<b>3</b>
SAS /ST/ E004	Seed Production and Cultivation of Medicinal and Aromatic Plants (MAPs)	<b>3</b>
SAS/ ST/E005	DUS Testing for Plant Variety Protection	<b>3</b>
SAS/ ST/E006	Weed Management in Crop Seed Production	<b>3</b>
SAS/ ST/E007	Hybrid Seed Production	<b>3</b>
SAS/ST/E008	Seed Entomology	<b>3</b>
<b>Total (B) REQUIRED CREDITS</b>		<b>18</b>
<b>Grand Total (A+B)</b>		<b>72</b>

**Self Study Course**

SAS/ ST/SS01	Emerging Trends in Seed Quality Enhancement	<b>3</b>
SAS/ ST/ SS02	Agriculture Research, Research Ethics and Rural Development Programmes	<b>3</b>

**Bridge Course**

* SAS/ ST/ BC01	Introductory Agriculture ( Fundamental Concepts)	<b>3</b>
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**SYLLABUS**  
**MASTER OF SCIENCE (AGRICULTURE)**  
**SEED SCIENCE AND TECHNOLOGY**  
*(From the academic session 2020-2021)*

**COURSE STRUCTURE**

CODES	COURSE TITLE	Total Marks	End Term Tests	Sessionals		Credits		Credits
				I	II	L	T	
<b>SEMESTER-I</b>								
SAS/ ST/ C001	Floral Biology, Seed Development and Maturation	100	60	20	20	2	1	3
SAS/ ST/ C002	Seed Production: Principles and Practices	100	60	20	20	2	1	3
SAS/ ST/ C003	Genetics and Plant Breeding	100	60	20	20	2	1	3
SAS/ ST/ C004	Physiology of Seed	100	60	20	20	2	1	3
SAS/ ST/ C005	Seed Processing , Storage and Deterioration	100	60	20	20	2	1	3
SAS/ ST/ C006	Laboratory Course - I	100	60	20	20			3
<b>Sub Total</b>		<b>600</b>						<b>18</b>
* SAS/ ST/ BC 01	Introductory Agriculture (A Fundamental Concept)	100	60	20	20			3
<b>SEMESTER-II</b>								
SAS/ ST/ C007	Principles and Techniques in Vegetable Seed production	100	60	20	20	2	1	3
SAS/ ST/ C008	Seed Legislation and Certification	100	60	20	20	2	1	3
SAS/ ST/ C009	Seed Quality Testing	100	60	20	20	2	1	3
SAS/ ST/ C010	Seed Health Technology and quarantine	100	60	20	20	2	1	3
SAS/ ST/ C011	Intellectual Property and its Management in Agriculture	100	60	20	20	2	1	3
SAS/ ST/ C012	Laboratory Course - II	100	60	20	20			3
<b>Sub Total</b>		<b>600</b>						<b>18</b>
<b>SEMESTER-III</b>								
SAS/ ST/ C013	Seed Marketing and Management	100	60	20	20	1	1	3
SAS/ ST/ C014	Seed Biotechnology	100	60	20	20	1	1	3
SAS/ ST/ C015	Laboratory Course - III	100	60	20	20			3
Elective Course	Elective Course-I	100	60	20	20	2	1	3

	Elective Course-II	100	60	20	20	2	1	<b>3</b>
	Elective Course-III	100	60	20	20	2	1	<b>3</b>
<b>Sub Total</b>		<b>600</b>						<b>18</b>
SAS/ ST/ SS01	Emerging Trends in Seed Quality Enhancement	100	60	20	20			<b>3</b>
<b>List of elective courses for III<sup>rd</sup> semester (Three papers to be selected)</b>								
SAS/ ST/ E001	Basic Concept in Lab. Techniques							
SAS/ ST/ E002	Germplasm Collection, Exchange and Quarantine							
SAS/ ST/ E003	Seed Production in Field Crops							
SAS /ST/ E004	Seed Production and Cultivation of Medicinal and Aromatic Plants (MAPs)							
<b>SEMESTER-IV</b>								
SAS/ ST/C016	Master's Research Thesis	100	60	20	20			<b>6</b>
SAS/ ST/C017	Laboratory Course - IV	100	60	20	20			<b>3</b>
	Elective Course-I	100	60	20	20	2	1	<b>3</b>
	Elective Course-II	100	60	20	20	2	1	<b>3</b>
	Elective Course-III	100	60	20	20	2	1	<b>3</b>
<b>Sub Total</b>		<b>500</b>						<b>18</b>
SAS/ ST/ SS02	Agriculture Research, Research Ethics and Rural Development Programmes	100	60	20	20			<b>3</b>
<b>List of elective courses for IV semester (Three papers to be selected)</b>								
SAS/ ST/E005	DUS Testing for Plant Variety Protection							
SAS/ ST/E006	Weed Management in Crop Seed Production							
SAS/ ST/E007	Hybrid Seed Production							
SAS/ ST/E008	Seed Entomology							
<b>Grand Total of Marks: (600+600+600+500) =2300</b>								
<b>Grand Total of Credits (Core 54 + Elective 18) = 72</b>								

**L- Lecture; T- Tutorial; P- Practical; C- Core course; E- Elective course; SS- Self Study Course and BC01- Bridge Course. (\*SAS/ ST/ BC 01; A Bridge Course only for Non-Agriculture Graduates.)**

The distribution of marks for the Master's Research Thesis will be as below:

Periodical presentation 20 Marks

Master's Research Thesis (External Evaluation) 60 Marks

Viva-Voce 20Marks

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**Total - - - - - 100 Marks**

# ***DEPARTMENT OF SEED SCIENCE AND TECHNOLOGY***

**H.N.B. Garhwal University (A Central University)  
Srinagar (Garhwal) Uttarakhand, India-246 174**

## **MASTER OF SCIENCE (AGRICULTURE) *SEED SCIENCE AND TECHNOLOGY* (From 2020-2021)**

### **Course Contents**

#### **SEMESTER-I**

##### **SAS/ ST/ C001 FLORAL BIOLOGY, SEED DEVELOPMENT AND MATURATION (2+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.

###### **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.

###### **Practical**

Study of floral biology of monocots and dicots; microsporogenesis and megasporogenesis; study of pollen grains - pollen morphology, pollen germination and pollen sterility; types



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, cross pollinated and vegetative 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; 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.

### **SAS/ ST/ C003      GENETICS AND PLANT BREEDING**

**(2+1)**

#### **Objectives:**

This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem solving skills from classical to molecular genetics. To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement. Also to provide understanding about mechanisms of heterosis and its exploitation for yield improvement through conventional and biotechnological approaches.

#### **UNIT-I**



Mendel's laws and modification of F<sub>2</sub> ratios; lethality, segregation distortion; penetrance and 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*

#### **UNIT-II**

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:

#### **UNIT-III**

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.

#### **UNIT-IV**

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.

#### **UNIT-V**

Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F<sub>2</sub> and segregating populations, importance of inbreeding in exploitation of heterosis – case studies. - Relationship between genetic distance and expression of heterosis – case studies.

#### **UNIT-VI**

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 inbreds 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; problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid.

#### **Practical**

Genetical exercises based on theory course, field observation on flower opening and anthesis; Hybridization techniques; field practice in emasculation and pollination. Collection of pollen and study of its viability and germination.

#### **Suggested Books:**

- Allard, R.W. 1960. Principles of plant breeding. 2<sup>nd</sup> ed. John Wiley & Sons. New York. Book Society. CBS.
- Chopra VL. 2004. Plant Breeding. Oxford & IBH.
- Griffith et al. 2000. An introduction to genetic analysis, 7<sup>th</sup> ed. W.H. Freeman & Co.
- Gupta SK. 2005. Practical Plant Breeding. Agribios.
- Gupta, P.K. 1998. Genetics 3<sup>rd</sup> ed. Rastogi Publ. Shivaji Road Meerut, 250 002.

- James R Wales 1981. Fundamentals of plant genetics and breeding. John Wiley & Sons, New York.
- Kapoor, R.L. 1997. Plant Breeding and Crop Improvement. 2 Vols
- Poehlman, J.M. And D. Borthakur 1969. Breeding Asian Field Crops. Oxford & IBH Publing Co. New Delhi.
- Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation.
- Sharma, J.R. 1996. Principles and Practice of Plant Breeding. Tata McGraw Hill Publ. Co. Ltd. New Delhi.
- Singh, B.D. 2006. Plant Breeding Principles and Methods. Kalyani Publ. New Delhi
- Snustad D. Peter; Simons, M.J. and Jenkins, J.B. 1999. Principles of genetics, 2<sup>nd</sup> ed. John Wiley & Sons, Inc., New York.
- T. Ramanathan, Applied Genetics of Oilseed Crops, Daya Publishing house Delhi.

## **SAS/ ST/ C004    PHYSIOLOGY OF SEED**

**(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, P.K. & M. Dadlani, 1995. Techniques In Seed Science And Technology (2<sup>nd</sup> Ed.) South Asian Publ. New Delhi.
- Agrawal, R.L. 1997. Seed Technology (IInd Ed.) Oxford & IBH Publ. Co. Daryaganj, New Delhi.
- 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, J. D. and Black, M. 1994. Seeds: (2Vols.) Physiology of Development and Germination. Plenum Press, New York.
- Carol, C. Baskin and Jerry, M. Baskin, (2005) Seed, Biogeography, and Evolution of dormancy and germination, (Elsevier), Academic Press.
- Copeland, R.A. 1996. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. VCH Publishers, New York.
- Devlin, R.M. & F.H. Witham 1983. Plant Physiology. CBS Publ. New Delhi.
- Hartman, H. T. & Kester, Dale E. 2000. Plant Propagation: Principles and Practices. (6<sup>th</sup> Ed.) Prentice-Hall of India. New Delhi.
- Khan AA. 1977. Physiology and Biochemistry of Seed Dormancy and Germination. North Holland Co.
- Kigel, J. and Galili, G. 1995. Seed development and germination. (eds).Marcel Dekker, New York
- McDonald, M.B. Nelson (eds). Physiology of seed deterioration. Crop Sci. Society of America, Madison
- Murray DR. 1984. Seed Physiology. Vols. I, II. Academic Press.
- Ninfa, A.J. and Ballou, D.P. 1998. Fundamental Laboratory approaches for Biochemistry and Biotechnology. Fitzgerald Science Press, Inc., Maryland, USA.
- Roberts, E.H. 1972. Viability of seeds. Chapman and Hall, New York

## **SAS/ ST/ C005 SEED PROCESSING, STORAGE AND DETERIORATION (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. Storage problems of recalcitrant seeds and their conservation.

## **UNIT- VI**

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.

## **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, P.K. & M. Dadlani, 1995. Techniques In Seed Science And Technology (2<sup>nd</sup> Ed.) South Asian Publ. New Delhi.
- Agrawal, R.L. 1997. Seed Technology (IInd Ed.) Oxford & IBH Publ. Co. Daryaganj, New Delhi.

- Bailly, R. Gregg, Alvin, G. Law, S.S. Virde and Balis, J.S. Seed Processing. Cooperatively published by NSC, New Delhi and Mississippi State University and UNSAID.
- Barton LV. 1985. Seed Preservation and Longevity. International Books and Periodicals Supply Service, New Delhi.
- Chakravarty, A. Post Harvest Technology of Cereals, Pulses and Oil Seeds.
- Copeland, R.A. 1996. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. VCH Publishers, New York.
- Desai, B.B., Kotecha. P.M. and Salunkhe, D.K. 1997. Seeds Handbook. Marcel Decker Inc., New York
- Justice, O.L. and Bass, L.N. 1978. Principles and practice of seed storage. USDA Agricultural Handbook no. 506, Washington. Castle House Pub. Ltd
- Khare Dharendra & Bhale Mohan S. 2000. Seed Technology. Scientific Publ. India
- Mc Donald, M.B. 1997. Seed Production: Principles and Practices.
- Sahay KM & Singh K. K. 1991. Unit Operations in Food Engineering. Vikas Publ.
- Simmonds, NW. 1979. Principles of Crop Improvement, Longman, London and New York.
- Virdi SS & Gregg BG. 1970. Principles of Seed Processing. National Seed Corp., New Delhi.

**\*SAS/ ST/ BC01      INTRODUCTORY AGRICULTURE      (2+1)**  
**(A FUNDAMENTAL CONCEPT)**  
**(Bridge Course only for Non-Agriculture Graduates)**

**UNIT-1-    Elementary Agriculture:**

Indian Agriculture-scope and resources; crop plants-their significance as source of food, feed fuel and raw material for industrial classification of crops according to seasons. Soils; their formation, classification, physical and chemical properties; manures and fertilizers, uptake of N,P &K by important crops, methods of manure and fertilizer application, composition of bulky organic manures and green manures. Irrigation and drainage-importance of water, quality of irrigation source methods and measurement of irrigation water. Cultivation of important crops in the states such as wheat, rice maize, rape seed and mustard, chickpea, pigeon pea, potato and sugarcane. Introduction to Plant Protection of Agricultural and Horticultural Crops.

**UNIT -2-    Fundamentals of Horticulture:**

Horticulture: its definition and branches; importance and scope; horticultural and botanical classification. Climate, soil and distribution of fruit species propagation and nursery raising. Acquaintance with horticultural crops such as cabbage, cauliflower, onion, garlic cucurbits, root crops, peas, tomato, brinjal, banana, apple, mango, litchi, citrus and guava. Principles of Orchard establishment and management. Causes of pollination, pollinisers and pollinators. Environmental and soil factors affecting vegetable production, kitchen gardening; garden types. Care and maintenance of ornamental plants. Knowledge of landscaping of rural and urban areas, use of plant bio-regulators in horticulture.

### **UNIT-3- Silviculture and Agro Forestry:**

Introduction; basic terms, concepts and scope, national and global need, growth and development of trees and forest. Plant succession kinds and causes, natural and artificial regeneration, establishment and care of tree nurseries tending operations cleaning, weeding, thinning and pruning. Classification, regeneration and crop characteristics of major silvicultural systems, selection and management of tree and crop species i.e. planning, density, silviculture, mixed farming, multiple cropping and agro forestry. Problems, choice and management of agro-forestry systems in various agro-climatic zones.

## **SEMESTER-II**

### **SAS/ ST/ C007 PRINCIPLES AND TECHNIQUES IN VEGETABLE SEED PRODUCTION (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; arvesting/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

- Arora, S.K. Hariyana Men Subjion ki Utpadan Prodhyokiki. Scientific Pub. India.
- B.P. Ghildyal and R.P. Gupta, 2002. Soil Structure: problems and Management, ICAR, New Delhi.
- Bassett, M.J. (1986) Breeding vegetable crops. AVI Publishing Comp.
- Dennis R. Decoteau (2000) Vegetable Crops. Prentice Hall.
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- Desai BB. 2004. Seeds Handbook. Marcel Dekker.
- George RAT. 1980. Vegetable Seed Technology. A Technical Guide to Vegetable Seed Production, Processing, Storage and Quality Control. FAO, Rome.
- Harihar Ram. (1997). Vegetable Breeding; Principles and Practices. Jagminder
- Hartman HT & Kester DE. 2000. Plant Propagation: Principles and Practices. Prentice Hall.
- Inns, N.L. (1983). Breeding field vegetables, Asian vegetable Research and Development Centre. Tainan...Taiwan
- ISTA (1983). Seed Technology in the tropic. The International Seed Testing Association, reprinted by Scientific Publishers, India
- Kelly AF & George RAT. (Eds.).1998. Encyclopedia of Seed Production of World Crops. John Wiley & Sons.
- Jeswani, L.M. and Baldev, B. (1997). Advances in pulse production technology, ICAR, New Delhi.
- McDonald MB Jr & Copeland LO. 1997. Seed Production of Crops: Principles and Practices. Chapman & Hall.
- Miller, B. McDonald and Lawrence O. Copeland, (1998). Seed Production: Principles and Practices. CBS publishers and distributors, 11 Darya Ganj, New Delhi.
- Mini, C. and Krishnakumary, K. (2004). Leaf Vegetables: Agrotech Publishing Academy, Sector-5, Hiran magri, Udaipur.
- Prem Singh Arya, (2000) Off-Season Vegetable Growing In Hills. A.P.H. Publishing Corporation, 5-Ansari Road, Daryaganj, New Delhi
- Salunkhe DK, Desai BB & Bhat RN. 1987. Vegetable and Flower Seed Production. Agricole Publ. Academy.
- Singh SP. 2001. Seed Production of Commercial Vegetables. Agrotech.
- Suman Bhati and Uma Verma (1997). Fruits and vegetable processing. CBS. Publ. Book Agency. New Delhi
- Work Paul (1997). Vegetable production and marketing. Daya Publ. House, Devram.

## **SAS/ ST/ C008                      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); 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.  
Tunwar NS & Singh SN. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.

## **SAS/ ST/ C009      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. 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.

#### **UNIT-IX**

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.

#### **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; testing coated/pelleted seeds.

#### **Suggested Readings**

- Agrawal PK. (Ed.). 1993. Handbook of Seed Testing. Ministry of Agriculture, GOI, New Delhi.
- Agrawal, R.L. 1975. Beej utpadan Evam Pramanikaran (Hindi). G.B.Pant Univ. of Ag. & Tech. Pantnagar.
- Agrawal, R.L. 1997. Seed Technology (IInd Ed.) Oxford & IBH Publ. Co. New Delhi.
- ANON. 1996. International rules for seed testing. Seed Science and Technology, 24 (suppl): 1-335
- AOSA. 1991. Cultivar purity testing handbook. Contribution no.33 to the Handbook on seed testing (MB McDonald & R. Payne, eds.) Assn. of Official Seed Analysts, Linkon.

Chalam, G.V and L. Neelkantam 1962. Improved Seed. Agricultural Production Manual, ICAR. New Delhi.ed. Chapman and Hall, New York.  
Copland LO & McDonald MB. 1996. Principles of Seed Science and Technology. Kluwer.  
F.A.O. Quality declared seeds 1997. (United Nations Rome.) Daya Publ. House  
ISTA(2008) International Rules For Seed Testing. ISTA, Bassersdorf, CH. Switzerland.  
ISTA 2006. Seed Testing Manual. ISTA, Switzerland.  
Martin C & Barkley D. 1961. Seed Identification Manual. Oxford & IBH.  
Nema, N.P. Principles of Seed Certification and Testing. Daya Publ. House  
Seed Act, 1966. Govt. of India, Manager Publications, G.I.O., New Delhi.  
Seed Rules, 1968. Govt. of India, Manager Publications, G.I.O., New Delhi.  
Tunwar NS & Singh SV. 1988. Indian Minimum Seed Certification Standards. Central Seed Certification Board, Ministry of Agriculture, New Delhi.

## **SAS/ ST/ C010 SEED HEALTH TECHNOLOGY AND QUARANTINE 3(2+1)**

### **Objective**

To acquaint the students with principles and practices of seed health tests 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 seed borne plant pathogens/diseases and procedure for healthy seed production; different seed health testing methods for detecting microorganisms; treatments to control seed borne diseases.

#### **UNIT-IV**

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.

## 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

- Agrawal, V.K. & Sinclair, J.B. 1997. Principles of Seed Pathology. Vol. I & II. CBS Pub. Delhi. (Boca Raton).
- Bawden, F.C. 1958. Plant Viruses and Virus disease. Wiltham Mass.
- Bhale, M.S., Khare, D., Raut, N.D. & Singh D. Seed borne diseases objectionable in seed production and their management. Scientific Publ. India
- Diction James, G. 1997. Diseases of Field Crops. Daya Publ. House.
- Jha, D.K. 1993. A Text Book on Seed Pathology. Vikash Publ. House, New Delhi.
- Jha, D.K. 1995. Laboratory Manual on Seed Pathology. Vikash Publ. House, New Delhi.
- Karuna V. 2007. Seed Health Testing. Kalyani Publishing.
- Mandhar, C.L. 1989. Plant Viruses. 2 Vols. Crc. Press, USA.
- Mehrotra, R.S. 2002. Plant Pathology. Oxford, New Delhi.
- Narayanasamy, P. 1998. Plant pathogen detection and disease diagnosis. Marcel Dekker, New York.
- Neergaard P. 1988. Seed Pathology, (2vols). Mac Millan.
- Nene, Y.L. & Thapliyal, P.N. Fungicides in plant disease control
- Prasad, M.M., Singh, B.K. & Prasad, T. 2001. Recent trends in disease management. Scientific Publ.
- Singh, R.S. 1969. Plant Diseases. Oxford & IBH. Calcutta.
- Singh, T. Seed Technology and Seed Pathology. Scientific Publ. India

## SAS/ST/ C011 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

(2+1)

### Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

### Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPs Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention

on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

### **Suggested Readings**

- Erbisch FH & Maredia K. 1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
- The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

## SEMESTER-III

### SAS/ ST/C013 SEED MARKETING AND MANAGEMENT (2+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

- Acharya, S.S. Agricultural marketing in India, Oxford and IBH., New Delhi.
- B.P. Ghildyal and R.P. Gupta, 2002. Soil Structure: problems and Management, ICAR, New Delhi.
- Hunt, D. 1968. Farm Power and Machinery Management, Vth edition, IOWA State, U.S.A.
- ISTA (1983). Seed Technology in the tropics. The International Seed Testing Association, reprinted by Scientific Publishers, India
- John, E. Kadlec, Farm management, Decision, operation, control. Prentice Hall, Inc. Englewood, Chiffs, New Jersey, U.S.A.
- Kahlon, A.S. and Singh Karan. Economics of farm management in India, Allied Publishers Pvt. Ltd., 13/14, Asaf Ali Road, New Delhi

- Kundu KK & Suhag KS. 2006. Teaching Manual on Seed Marketing and Management. Department of Agricultural Economics CCS HAU Hisar.
- Micheal, D. Boehlje and Verman, R. Ediman. Farm Management. Kalyani Publishers.
- Miller, B. McDonald and Lawrence O. Copeland, 1998. Seed Production: Principles and Practices. CBS publishers and distributors, 11 Darya ganj, New Delhi.
- Raju, V.T and Rao, DVS. Economics of farm production and management, IBH Publishing Comp. Pvt. Ltd., New Delhi.
- 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.
- Vigneshwara Varmudy 2001. Marketing of vegetables in India.

**SAS/ ST/C014**

**SEED BIOTECHNOLOGY**

**(2+1)**

**Objectives**

The course is aimed at understanding the basic concepts of seed biotechnology and to impart theoretical knowledge and practical skills used in agricultural biotechnology.

**Unit-I**

Introduction and brief history of biotechnology, Scope of biotechnology in conservation of quality seeds and their improvement. Tools and techniques of Tissue culture. Different culture methods and regeneration protocols for plants, media for in vitro culture - minerals, vitamins, and natural adjuvant like coconut milk, auxins, cytokinins, antioxidants and other growth regulators. Solid and liquid media. Commercial prepacked media. Design of laboratory and commercial tissue culture facility.

**Unit-II**

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 axenic cultures. Explants for Tissue Culture: Totipotency, Shoot tip, axillary buds, leaf discs, cotyledons, inflorescence and floral organs. Callus culture - initiation and maintenance of callus. Direct and indirect organogenesis and embryogenesis, caulogenesis, somatic embryogenesis, acclimatization. Somaclonal variation and its application for plant improvement

**Unit-III**

Problems encountered in genetic conservation, production of haploids, embryo culture and embryo rescue technique, Anther and pollen culture production of dihaploids 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 tissue culture.

**Unit-IV**



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.

## **PRACTICAL:**

Familiarity with organization and components of tissue culture and biotechnology laboratory. Different laboratory procedures Viz; sterilization of space, instruments, plant material and inoculation procedure etc. Composition of various culture media, their preparation, sterilization, handling etc. Introduction to techniques of pollen culture, anther culture and suitable media preparation. Introduction to techniques of embryo culture. SDS-PAGE, Native Electrophoresis, Blotting techniques.

## **Suggested Books:**

- Batra, Amla. 2001. Fundamentals of plant Biotechnology, Capital Publ. Comp. 7/28, Mahaveer Street, Ansari Road, Daryaganj, New Delhi-110 002.
- Bhojwani, S.S. and Razdan, M.K. (Eds.) 1996). Plant Tissue Culture: Theory and Practice; Revised Edition, Elsevier, Amsterdam.
- Brown T.A. Gene Cloning: An introduction. VNA Co. Ltd., U.K.
- Hand book of plant cell culture. Eds. Evans DA, Sharp W.R, Ammirato P.V & Tamada Y (Eds.) McMillan, New York, 1983.
- Kalyan Kumar De (2004). An introduction to Plant Tissue Culture. New central Book Agency,(P) Lte, Culcutta.
- Kumar, A. and Kumar, V.A. 1996. Plant Biotechnology and Tissue Culture. Principles and perspectives. International Book distributing Comp. Lucknow.
- Mantell, S.H. Matthews, J.A, McKee and Blackwell, R.A. Principles of plant Biotechnology. Scientific Publishers, 1987.
- Mantell, S.H and Smith, H. 1983. (Eds.) Plant Biotechnology. Cambridge University Press, Cambridge.
- Purohit, S.S. 2001. Biotechnology: Fundamentals and Applications. Agrobios (India) Publ. Agro House, behind Nasrani Cinema, Chopasani Road, Jodhpur-342 002.
- Purohit, S.S. (2003) Agricultural Biotechnology, second enlarge Edition, Agrobios(India)
- Ramawat, K.G. 2003. Plant Biotechnology. S. Chand & Co., Ram Nagar, New Delhi-110055.
- Redenbaugh, K. (Ed) 1993. Synseeds: Application of synthetic seeds to crop improvement, CRC Press, Boca Raton, Florida.
- Y.P.S. Bajaj (Ed), 1989. Plant protoplast and genetic engineering. I. II. Springer, Verlag, Berlin,

## SAS/ ST/ E001      BASIC CONCEPTS IN LABORATORY TECHNIQUES    (2+1)

### Objective

To acquaint the students about basics of commonly used techniques in laboratory.

### Theory

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vascupets; 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.

### Practicals

Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications. Preparation of solutions of acids; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, water bath, oil bath;. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

### Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

## SAS/ ST/E002 GERMLASM 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.

## **SAS/ ST/ E003 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 incross-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, beans, peas etc.).

#### **UNIT-IV**

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.).

#### **UNIT-V**

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in vegetatively propagated crops like zinger, potato and 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 and visits to seed production plots etc.

### **Suggested Readings**

- A.J.G. van Gestel. Seed Science & Technology. Scientific Publ. India
- Agrawal, P.K. & M. Dadlani, 1995. Techniques in Seed Science and Technology (2<sup>nd</sup> Ed.) South Asian Publ. New Delhi.
- Agrawal, R.L. 1997. Seed Technology (IInd Ed.) Oxford & IBH Publ. Co. Daryaganj, New Delhi.
- B.P. Ghildyal and R.P. Gupta, 2002. Soil Structure: problems and Management, ICAR, New Delhi.
- Carol, C. Baskin and Jerry, M. Baskin, (2005) Seed, Biogeography, and Evolution of dormancy and germination, (Elsevier), Academic Press.
- Chopra, V.L. Plant Breeding Theory and Practice. Oxford and IBH Publishing Co. New Delhi.
- Dadheech, P.K. 1996. Seed programming Management system and concept. Scientific Publ. India
- Karan Singh and Bajrang Lal Kankralia 2004. Beejon ka adhunik Jeevwigyan. Anupryogic avam maulik. (Modern Biology of Seeds: Applied and Basic)Pointer Publishers, Jaipur, Rajasthan.
- F.A.O. 2001 Training for Agriculture and Rural Development. Daya Publ. House, Devram.
- Feistritzer, W.P. 1982. Ed. Technical Guidelines for maize seed technology. FAO of the United Nations, Rome.
- Frankel, R. and Galun, E. 1977. Pollination mechanisms, Reproduction and Plant Breeding. Springer – Verlag, Berlin.
- Kelly AF. 1988. Seed Production of Agricultural Crops. John Wiley.
- McDonald M.B. & Copeland, L.O. 1999. Seed Science & Technology, Laboratory Manual. Scientific Publ. India.
- McDonald MB Jr & Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall.
- Poehlman, J.M. And D. Borthakur 1969. Breeding Asian Field Crops. Oxford & IBH Publing Co. New Delhi.
- Rajendra Prasad (2004) Text Book of Field Crops Production, ICAR, Krishi Anusandhan Bhavan, Pusa, New Delhi.
- Singhal NC. 2003. Hybrid Seed Production in Field Crops. Kalyani

## SAS/ ST/ E004    Seed Production and Cultivation of Medicinal and Aromatic Plants (MAPs)

1. History : Descriptions in Ayurveda, and other Indigenous Systems of Medicine, Floras, Materia Medica, The Wealth of India, Compendiums of MAP's.
2. Classification of MAPs according to botanical and chemical characteristics and uses.
3. Organization related to conservation, domestication, cultivation and financial assistance.
4. Processes and consequences in plant introduction, domestication and acclimatization : Gene pool concept,
5. Secondary metabolites and essential oils in plants and their uses: Sterols, Saponins and Alkaloids, Phenolic compounds in plants.
6. Growth and Development, Biomass partitioning, phenology and life cycles.
7. 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.
8. Package of practices of some important MAP's (*Gloriosa superba*, *Aloe vera*, *Tinospora cordifolia*, *Pellargonium graveolense*, *Asparagus racemosus*, *Becopa mooneri*, *Lavender*, *Citronella*, *Stevia rebaudiana*, *Withania somnifera*) under the following heads:  
Plants description, Distribution, economic importance, active constituents, seed germination/multiplication (Tissue Culture practices), yield analysis. Latest research and present trends for the advancement in cultivation technology, processing, utilization and quality aspects.
9. Commercial trade in MAP's: marketing, distribution, publicity, import and export, quality control
10. Work plan for seed production, seed production organizations in world.
11. Varietal verification: modern techniques and applications
12. Convention on biological diversity(CBD), Convention on International Trade in Endangered Species of wild flora and fauna (CITES), Intellectual Properrity Rights, Patents, and Copyrights

### Practical:

1. Soil testing: Texture, N, P, K, soil pH, Carbon
2. Germination test: Effect of light, temperature and growth hormones, Seed polymorphism
3. Quantitative and qualitative isolation of Protein, DNA and RNA
4. Yield analysis: crop and seed
5. Processing techniques: collection, drying, grading, packing and storage

6. Vegetative propagation and in-vitro multiplication techniques
7. Biocomposting and vermicomposting methods

### **Suggested Books:**

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

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

An introduction to practical Biochemistry, IIIrd edition, David T. Plummer, Tata McGraw, Hill Publ. Comp. New Delhi.

Cultivation and Utilization of Medicinal Plants: S. S. Handa and M. K. Kaul R. R. Jammu. 1996

Economic Botany: Eams

Hand Book of Agriculture-ICAR Publication, 1997.

Identification of common Indian Medicinal Plants, V.N. Naik, ( ) Scientific Publisher,

Materia medica, Henry G. Greenish, 1999. Scientific publisher India New Pali Road Jodhpur,

Medicinal Plants and Minerals of Uttarakhand Himalaya: Uniyal, M.R.

Medicinal Properties of Plant, Antifungal, Antibacterial, Antiviral Activity: A.B. Ray, B.K. Sharma & U.P. Singh, International Book distribution comp. Lucknow.

Organic manures- Gaur, Neelkantan and Dargan, ICAR New Delhi, 2002

Package of Practices for Organic Cultivation and Utilization of Important Medicinal Plants (Part-I): P. Pushpangadan, S. Mehrotra, A. K. S. Rawat, S. K. Tiwari, R. L. S. Sikarwar and N. Mishra, Econmic Botany Information Service, National Botanical Research Institute, Lucknow

Plant Physiology: Salisbary and Ross

Quality Standards of Indian Medicinal Plants: A.K. Gupta, Indian Council of Medical Research, New Delhi

Research and Methods in Plant Sciences: Allelopathy- Vol. I, Soil analysis

Seed quality basic mechanism and agricultural implications, Amarjeet, S, Basra. CBS. Publishers and Distributors.

Soil and green house effect. Monitoring and mitigation, H. Pathak & S. Kumar. CBS Publisher and Distributors, New Dcelhi.

Soil Structure-Problem and Management, B. P. Ghildiyal and R. P. Gupta, 2002.

Text Book of Soil Science, T. D. Biswas and S. K. Mukherjee, 2005.

Vermicomposting: Gupta

## **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 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, bioprimering.

### **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 & McDonald MB. 2004. Seed Science and Technology. Kluwer Acad.
- Kaloo G, Jain SK, Vari AK & Srivastava U. 2006. Seed: A Global Perspective. Associated Publishing Company, New Delhi.



## SEMESTER-IV

### SAS/ ST/E005 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- 1

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- 2

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- 3

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.

### SAS/ ST/E006 Weed Management in Crop Seed Production (2+1)

##### UNIT-1.

Introduction: Weeds Defined, History of weed control, Weed Classification, Know about Weeds, Botanical families of Troublesome Weeds, Weed Crop Competition. Losses caused by weeds, Competition for Growth Requirement, Soil Water, Mineral Nutrients, Adverse Influence Through Allelopathy; Leaf Litter, Seeds and Rhizomes, Roots and Rhizomes, Impair the Quality of Crop Products. Alternate Hosts to Insect Pests and Diseases, Harmful to Human Health and Comforts. Weed ecology, Weed Seeds, Weed Seed Bank.

##### UNIT-2.

Weed resistance, plant responses, crop tolerance, utility, Herbicide-plant selectivity; Physical Factors, Biological Factors, Inherent Properties of Herbicides, Chemical Plant Protestants, Chemical Herbicide Protestants, Herbicide Agrochemicals Interactions, Herbicide Resistant Weed Biotypes,

### **UNIT-3.**

Formulations and surfactants: Carrier; Formulations, Mixtures of Chemical Formulations, Surfactants, adjuvant; Surfactants, Wetting Action of Surfactants, Stabilizing Agents; Utility of Emulsifiers, Kinds and composition of Herbicide Emulsion, Important feature of invert emulsifiers, Nature of action of emulsion, Preparation of emulsion spray liquids, Coupling agents (Solvents and Co-solvents), Humicants (Hygroscopic agents), Deposit builders (Stickers or Filming Agents), Compatibility agents, Activators; Phytoblend oils, Isoparaffinic Oils, Ammonium Thiocyanate, Trichlorobenzyl Chloride, Nitrogen Fertilizer, Drift control agents; Thickening agents, Particulating agents, foams.

### **UNIT-4.**

Herbicide application equipments: Kinds of Sprayer; Knapsack Sprayers, Foot Sprayers (Pedal Pump Sprayer), Tractor Powered Sprayers, Aerial Sprayers, Hand Held Sprayers. Granule Applicators, Herbigation, Rouging Gloves. Sprayer's calibration and herbicide calculations; Sprayers calibration, calibration procedures; pulled sprayers, hand sprayers, herbicide calculations. Fate of herbicide in plants; Symmetrical Triazines, Uracils, Urea, Hydroxyl Benzotrioles, Ioxynil and Bromoxynil; Dichlobenil, Quaternary Ammoniums, Nitrophenols, Inorganic Copper Based and Arsenial Herbicides, Diazines, Maleic Hydrazide; Pyrazon, Carbonates, Dinitroanilines, Phenoxy Alkanoic Acids and Benzoic Acids, Pyridines, Picloram; Fluridone, Aliphatic Acids, Anilines and Toluidines, Sulfonylurea Ethers. Fate of herbicides in soils; Adsorption, Factors Affecting Herbicide Adsorption, Specific Adsorption Behavior of Some Herbicides, Movement, Leaching; Volatile Movement, Wash-off and Run-off, Plant Removal, Decomposition, Microbial Decomposition; Chemical Decomposition, Photo Decomposition, Minimizing Herbicide Persistence in Soils, Herbicide Effects on Soil Microorganisms, tillage and weed control; Weed Control, Tillage Terminology.

### **UNIT-5.**

Description of some common weeds; *Chenopodium album*, *euphorbia hirta*, *amaranthus viridis*, *Solanum nigrum*, *Achyranthus aspera*, *Leucas aspera*, *Amaranthus spinosus* L. , *Argemone mexicana* L., *Boerhaavia diffusa* L., *Calotropis gigantea* R.Br., *Celome viscosa*, L., *Phyllanthus niruri* L., *Xanthium strumarium* L.,

### **UNIT-6**

Problem weeds and their control; Grasses *Cynodon dactylon*, *Avena* sp. Parasitic weeds, *Orobanche* spp., *Cuscuta* spp., Broad leaf weeds, *Lantana camara* L. *Eupatorium odoratum* L., *Parthenium hysterophorus*, Sedges. Biological weed control; Biotic Agents for weed control, Selection of Biotic Agents, Host Specificity of Insects, Plant Pathogens for Weed Control, Biological Control of Terrestrial Weeds,

### **Practical:**

Field identification and control of important weeds.

### **Suggested Readings:**

- K. Rammoorthy and P. Subbian (2006) Weed Management, Agrotech Publishing Academy, Hiran Magri, Udaipur. ISBN: 81-8321-034-1
- O.S. Bindra and H. Singh (1971) Pesticide application equipment. Oxford and IBH Pbl. Comp. New Delhi
- M. Devine et al. (1992) Physiology of herbicide action. Prentice Hall. XII: 441 PB.
- C. Eedtke (1982). Biochemistry and Physiology of herbicide action. Springer Verlag.
- R.J. hance (1980). Interaction between herbicides and the soil. Academic Press London.

## **SAS/ ST/E007      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 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.

**SAS/STS/ 008**

**SEED ENTOMOLOGY**

**3 (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-IV**

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

### **Practicals**

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 handling 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, N.A. and Girish, G.K. 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, J.A. and Aleock, A.W. 1954. *Storage of Cereal Grain & their Products*. American Assoc. Cereal Chemists, St. Pauls, Minn.

Cottong, R.T. 1963. *Insect Pests of Stored Grain and Grain Products*. Burgess Publ. Co., Minneapolis, Minn., USA.

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

Subramanyam, B. and Hagstrum, D.W. 1995. *Interrelated Management of Insects in Stored Pro*

## **SAS/ ST/SS02      AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES      (3)**

### **Objective**

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

### **Theory**

#### **UNIT-I**

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; International fellowships for scientific mobility.

#### **UNIT-II**

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

#### **UNIT-III**

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural 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.

### **Suggested Readings**

- Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.  
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.  
Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.  
Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

## **SEED SCIENCE AND TECHNOLOGY**

### **List of Journals**

- Crop Science
- Hort. Science
- Acta Horticultrae
- 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](http://www.bioreporter.com)
- Agricultural Research Magazine [www.ars.usda.gov/is/AR/](http://www.ars.usda.gov/is/AR/)
- American Seed Trade Association [www.amseed.com](http://www.amseed.com)
- Association of Official Seed Certifying Agencies [www.AOSCA.org](http://www.AOSCA.org)
- Association of Official Seed Analysts [www.aosaseed.com](http://www.aosaseed.com)
- Commercial Seed Analysts Association of Canada [www.seedanalysts.com](http://www.seedanalysts.com)
- Front Range Seed Analysts [www.frsa.org](http://www.frsa.org)
- International Seed Federation [www.wordseed.org](http://www.wordseed.org)
- International Seed Testing Association [www.seedtest.org](http://www.seedtest.org)
- International Society for Seed Science [www.css.comell.edu/ISSS/iss.htm](http://www.css.comell.edu/ISSS/iss.htm)
- International Society of Seed Technologists [www.isstech.org](http://www.isstech.org)

- The Seed Biology web page at Cornell University  
[www.css.cornell.edu/seedbio/seedbio.html](http://www.css.cornell.edu/seedbio/seedbio.html)
- Seed Biology at the Laboratory of Plant Physiology at the Wageningen University  
[www.wau.nl/uk/organisation](http://www.wau.nl/uk/organisation)
- The Ohio State Seed Biology webpage [www.css.ohio-state.edu/%7Eseebio/](http://www.css.ohio-state.edu/%7Eseebio/)
- The Seed Biotechnology Center University of California <http://sbc.ucdavis.edu>
- Seed Viability and Storage Research Unit [www.arsgrain.gov/ars/NoPlains/FtCollins/preservation.htm](http://www.arsgrain.gov/ars/NoPlains/FtCollins/preservation.htm)
- Seed World [www.seedworld.com](http://www.seedworld.com)
- Seed Quest [www.seedquest.com](http://www.seedquest.com)
- Seed Today [www.seedtoday.com/info/ST sites.html](http://www.seedtoday.com/info/ST_sites.html)
- The South African National Seed Organization [www.sansor.org/index.htm](http://www.sansor.org/index.htm)
- Society of Commercial Seed Technologists [www.seedtechnology.net](http://www.seedtechnology.net)
- Wageningen Seed Centre [www.seedcentre.nl](http://www.seedcentre.nl)