FACULTY OF AGRICULTURAL SCIENCES

ORDINANCE

Ph.D. Agriculture

(2021-22)

SHREE GURU GOBIND SINGH TRICENTENARY UNIVERSITY

GURUGRAM (DELHI-NCR)

Table of Contents

Eligibility Criteria for Admission to Ph.D. Agriculture

The minimum qualification for admission to Ph.D. programme shall be governed by the eligibility criteria stipulated in SGT University Common Ordinance (SGTU Regulations-2020). The candidates seeking admission in PhD must have obtained Masters Degree in concerned subject/field of specialization. There will be an entrance examination covering the syllabus prescribed by ICAR for the subject and or by the SGT University. The procedure of admission, duration of course, fee refund etc. will be governed by as per SGT University regulations. The syllabus of each subject is provided in the ordinance.

The candidates, who are awarded Fellowship by ICAR/CSIR/UGC, will be admitted to the Ph.D. programme of the University against additional seats in the concerned discipline without Entrance Test conducted by SGTU. The candidates who have not been awarded Fellowship but cleared the examination conducted by ICAR / CSIR/UGC are required to appear in the Entrance Test conducted by SGTU for admission to Ph.D. programme.

No admission in Ph.D. programme shall be made after the last date of admission.

CREDIT REQUIREMENTS:

Subject	Doctoral Program
Major	15
Minor	08
Supporting	05
Seminar	02
Research	45
Total Credits	75
Compulsory Non Credit Courses	See relevant section

Explanation:

Major subject: The subject (department) in which the student takes admission.

Minor subject: The subject closely related to student's major subject (eg. If major subject is Entomology, the appropriate minor subjects should be Plant Pathology and Nematology or as decided by the Faculty Research Committee on the recommendation of Research Advisory Committee of the student).

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for students research work.

Non-credit Compulsory Courses: Please see relevant section for details. PhD students may be exempted from these courses if already studied during Master's degree.

Service Course: A course offered for other disciplines, and not to be counted towards major credits by the department teaching that course.

NON CREDIT COMPULSORY COURSES:

Course Code	Old Code	Course Title	Credits	Semester
11060111	PGS 501	LIBRARY AND INFORMATION SERVICES	0+1	I
11060204	PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1	II
11060205	PGS 503	INTELLECTUAL PROPERTY AND ITS	1+0	II

	(e-Course)	MANAGEMENT IN AGRICULTURE		
11060306	PGS 504 (e-Course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0	III
11060106	PGS 505 (e-Course)	DISASTER MANAGEMENT	1+0	I
	HINDI-1*	Prarambhik Hindi	3+0	I, II

*Compulsory for M.Sc. or Ph.D. programmes in respect of foreign students only.

Note: One course of Statistics (3 credit) is compulsory at Ph.D. (if not studied statistics course in Master's programme).

11060111	**Library & information services**	**0+1**	**Sem- I, II**

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

11060204	**Technical writing & communication skills**	**0+1**	**Sem- I, II**

Objective

- To equip the students/scholars with skills to write dissertations, research papers, etc.
- To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship, contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of*(iv)* numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995. Harper Collins.

Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.

Gupta RH. 2010. Essentials of Communication. 7th Ed. Pragati Prakashan.

Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.

James HS. 1994. Handbook for Technical Writing. NTC Business Books.

Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.

Mohan K. 2005. Speaking English Effectively. MacMillan India.

Richard WS. 1969. Technical Writing. Barnes & Noble.

Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.

Abhishek. Sethi J &Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.

11060205	**Intellectual property & its management in agriculture (e-Course)**	**1+0**	**Sem-I, II**

Objective

The main objective of this course is to equip students and stake holders 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 bio-diversity 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 Act2001, and Rules 2003; National Biological Diversity Act, 2003.

11060306	**Agricultural research, research ethics & rural development programmes (e-Course)**	**1+0**	**Sem- I, II**

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programs 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 programs: 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 programs. Constraints in implementation of rural policies and programs**.**

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.

11060106	**Disaster management (e-Course)**	**1+0**	**Sem- I, II**

Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heatand cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy.

Orient Blackswan. Hodgkinson PE & Stewart M. 1991.Coping with Catastrophe: A Handbook of Disaster Management.

Sharma VK. 2001. Disaster Management. National Centre.

AGONOMY

Field of Specialization: Agrostology, Crop Ecology, Crop Nutrition, Crop Physiology, Crop Production, Water Management, Weed Science.

Major:

Course Code	Old Code	Course Title	Credits	Semester
11020101*	AGRON 601*	CURRENT TRENDS IN AGRONOMY	3+0	II
11020102	AGRON 602	CROP ECOLOGY	2+0	II
11020103*	AGRON 604*	ADVANCES IN CROP GROWTH AND PRODUCTIVITY	2+1	II
11020104	AGRON 605	IRRIGATION MANAGEMENT	2+0	II
11020105	AGRON 606	ADVANCES IN WEED MANAGEMENT	2+0	I
11020106	AGRON 607	INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE	2+0	II
11020107	AGRON 609	STRESS CROP PRODUCTION	2+1	I
11020108	AGRON 691	DOCTORAL SEMINAR I	1	I, II
11020109	AGRON 692	DOCTORAL SEMINAR II	1	I, II
11020110	AGRON 699	DOCTORAL RESEARCH	45	

*Compulsory courses.

COURSE CONTENT

11020101	Advanced trends in Agronomy	3+0	Sem- II

Objective
To acquaint the students about recent advances in agricultural production.

Theory

UNIT-I

Agro-physiological basis of variation in yield, recent advances in soilplant-waterrelationship.

UNIT-II

Globalization of agriculture and WTO, precision agriculture, contract farming,organic farming, marketing and export potential of organic products, certification, labelling and accreditation procedures.

UNIT-III

Crop residue management in multiple cropping systems; latest developments inplant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy.

UNIT-IV

GIS, GPS and remote sensing for crop management, global warming, GMcrops, seed production technology; seed certification, seed multiplication, hybrid seedproduction etc.

UNIT-V

Concepts of system agriculture; holistic approach of farming systems, drylandfarming, sustainable agriculture and research methodology in Agronomy.

Suggested Readings

Agarwal RL. 1995. Seed Technology. Oxford & IBH.

Dahiya BS & Rai KN. 1997. Seed Technology. Kalyani.
Govardhan V. 2000. Remote Sensing and Water Management in Command Areas:
AgroecologicalProspectives. IBDC.ICAR. 2006. Hand Book of Agriculture. ICAR.
Narasaiah ML. 2004. World Trade Organization and Agriculture. Sonali Publ.
Palaniappan SP &Annadurai K. 2006. Organic Farming - Theory and Practice. Scientific Publ.
Sen S & Ghosh N. 1999. Seed Science and Technology. Kalyani.
Tarafdar JC, Tripathi KP & Mahesh Kumar 2007. Organic Agriculture Scientific Publ.

11020102	**Advanced crop ecology**	**2+0**	**Sem - II**

Objective

To acquaint the students about the agricultural systems, agro-ecological regions, and adaptation of crops to different agro-climatic conditions.

Theory

UNIT-I

Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply.

UNIT-II

Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.

UNIT-III

Physiological response of crop plants to light, temperature, CO2, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.

UNIT-IV

Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production.

UNIT-V

Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices; improvement of unproductive lands through crop selection and management.

Suggested Readings

Ambasht RS. 1986. A Text Book of Plant Ecology. 9th Ed. Students' Friends & Co.
Chadha KL &Swaminathan MS. 2006. Environment and Agriculture. Malhotra Publ. House.
Dwivedi P, Dwivedi SK &Kalita MC. 2007. Biodiversity and Environmental Biotechnology. Scientific Publ.
Hemantarajan A. 2007. Environmental Physiology. Scientific Publ.
Kumar HD. 1992. Modern Concepts of Ecology. 7th Ed. Vikas.Publ.
Lenka D. 1998. Climate, Weather and Crops in India. Kalyani.
Misra KC. 1989. Manual of Plant Ecology. 3rd Ed. Oxford & IBH.
Pandey SN & Sinha BK. 1995. Plant Physiology. Vikas Publ.
Sharma PD. 1998. Ecology and Environment. Rastogi Publ.
Singh J & Dhillon SS. 1984. Agricultural Geography. Tata McGraw Hill
Taiz L &Zeiger E. 1992. Plant Physiology. Benjamin/Cummings Publ.

11020103	Advances in crop growth & productivity	2+1	Sem - II

Objective

To study the physiology of vegetative and reproductive growth in relation to productivity of different crops in various environments.

Theory

UNIT-I:

Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception ofsolar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

UNIT-II:

Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

UNIT-III:

Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.

UNIT-IV:

Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Practical

- Field measurement of root-shoot relationship in crops at different growth stages
- Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at
- different stages of crop growth
- Computation of harvest index of various crops
- Assessment of crop yield on the basis of yield attributing characters
- Construction of crop growth curves based on growth analysis data
- Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping
- Senescence and abscission indices
- Analysis of productivity trend in un-irrigated areas
- Analysis of productivity trend in irrigated areas

Suggested Readings

Chopra VL & Paroda RS. 1984. Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants. Oxford & IBH.

Delvin RM & Vitham FH. 1986. Plant Physiology. CBS Publ.

Evans LT. 1975. Crop Physiology. Cambridge Univ. Press.

Evans LT. 1996. Crop Evolution, Adaptation and Yield. Cambridge Univ. Press.

Gupta US. (Ed.). 1995. Production and Improvement of Crops for Drylands. Oxford & IBH.

Gupta US. 1988. Progress in Crop Physiology. Oxford & IBH.
Kramer PJ & Boyer JS. 1995. Water Relations of Plant and Soils. Academic Press.
Mukherjee S & Ghosh AK. 1996. Plant Physiology. Tata McGraw Hill
Narwal SS, Politycka B &Goswami CL. 2007. Plant Physiology: Research Methods. Scientific Publications.

11020104	**Irrigation management**	**2+0**	**Sem- II**

Objective
To teach students about optimization of irrigation in different crops under variable agroclimatic conditions.

Theory

UNIT-I
Water resources of India, irrigation projects; irrigation needs, atmospheric, soil,agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

UNIT-II
Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity.

UNIT-III
Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

UNIT-IV
Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

UNIT-V
Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

UNIT-VI:
Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Suggested Readings
FAO. 1984. Irrigation Practice and Water Management. Oxford & IBH.
Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.
Mishra RR & Ahmad M. 1987. Manual on Irrigation and Agronomy. Oxford & IBH.
Panda SC. 2003. Principles and Practices of Water Management. Agrobios.
Reddy SR. 2000. Principles of Crop Production. Kalyani.
Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In:
Gupta US. (Ed.). Production and Improvement of Crops for Drylands. Oxford & IBH.
Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US.(Ed.).
Production and Improvement of Crops for Drylands. Oxford & IBH.

11020105	Advances in weed management	2+0	Sem- I

Objective

To teach about the changing weed flora, new herbicides, their resistance, toxicity, antidotes and residue management under different cropping systems.

Theory

UNIT-I

Crop-weed competition in different cropping situations; changes in weed flora, various causes and effects.

UNIT-II

Physiological and biological aspects of herbicides, their absorption,translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

UNIT-III

Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants.

UNIT-IV

Advances in herbicide application techniques; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides.

UNIT-V

Development of transgenic herbicide resistant crops; herbicide development, registration procedures.

UNIT-VI

Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides, allelochemical herbicide bioassays.

Suggested Readings

Aldrich RJ & Kramer R.J. 1997. Principles in Weed Management. Panama Publ.

Ashton FM & Crafts AS. 1981. Mode of Action of Herbicides. 2nd Ed. Wiley-Inter Science.

Gupta OP. 2000. Weed Management – Principles and Practices. Agrobios.

Mandal RC. 1990. Weed, Weedicides and Weed Control - Principles and Practices. Agro-Botanical Publ.

Rao VS. 2007. Principles of Weed Science. Oxford & IBH.

Ross MA &CarolaLembi A. 1999. Applied Weed Science. 2nd Ed. Prentice Hall.

Subramanian SAM & Kumar R.J. 1997. All About Weed Control. Kalyani.

Zimdahl RL. 1999. Fundamentals of Weed Science. 2nd Ed. Academic Press.

11020106	Integrated farming systems & sustainable agriculture	2+0	Sem - II

Objective

To apprise about different enterprises suitable for different agro-climatic conditions for sustainable agriculture.

Theory

UNIT-I

Farming systems: definition and importance; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises.

UNIT-II

Concept of sustainability in farming systems; efficient farming systems; natural resources-identification and management.

UNIT-III

Production potential of different components of farming systems; interaction and mechanism of different production factors; stability in different systems through research; eco-physiological approaches to intercropping.

UNIT-IV

Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems.

UNIT-V

New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

Suggested Readings

Ananthakrishnan TN. (Ed.) 1992. Emerging Trends in Biological Control of

Phytophagous Insects. Oxford & IBH.

Balasubramanian P &Palaniappan SP 2006. Principles and Practices of Agronomy. Agrobios.

Joshi M &Parbhakarasetty TK. 2005. Sustainability through Organic Farming. Kalyani. Lampin N. 1990. Organic Farming. Farming Press Books.

Palaniappan SP &Anandurai K. 1999. Organic Farming - Theory and Practice. Scientific Publ.

Panda SC. 2004. Cropping systems and Farming Systems. Agribios.

Reddy MV. (Ed.). 1995. Soil Organisms and Litter Decomposition in the Tropics. Oxford & IBH.

Sharma AK. 2001. A Hand Book of Organic Farming. Agrobios.

Singh SP. (Ed) 1994. Technology for Production of Natural Enemies. PDBC, Bangalore.

Trivedi RN. 1993. A Text Book of Environmental Sciences. Anmol Publ.

Veeresh GK, Shivashankar K & Suiglachar MA. 1997. Organic Farming and Sustainable Agriculture. Association for Promotion of Organic Farming, Bangalore.

Venkata Rao BV. 1995. Small Farmer Focused Integrated Rural Development: Socioeconomic

Environment and Legal Perspective. Publ. 3. Parisaraprajna Parishtana, Bangalore.

11020107	**Stress crop production**	**2+1**	**Sem- I**

Objective

To study various types of stresses in crop production and strategies to overcome them.

Theory

UNIT-I

Stress and strain terminology; nature and stress injury and resistance; causes of stress.

UNIT-II

Low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature tress through, soil and crop manipulations.

UNIT-III

High temperature or heat stress: meaning of heat stress, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations.

UNIT-IV

Water deficit stress: meaning of plant water deficient stress and its effect on growth and development, water deficit injury and resistance, practical ways to overcome effect of water deficit stress through soil and crop, manipulations.

UNIT-V

Excess water or flooding stress: meaning of excess water stress, its kinds and effects on crop plants, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations.

UNIT-VI

Salt stress: meaning of salt stress and its effect on crop growth, salt stress injury and resistance in plants, practical ways to overcome the effect of salt stress through soil and crop manipulations.

UNIT-VII

Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance.

UNIT-VIII

Environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution.

Practical

- Determination of electrical conductivity of plant cell sap
- Determination of osmotic potential and tissue water potential
- Measurement of transpiration rate
- Measurement of stomatal frequency
- Growing of plants in sand culture under salt stress for biochemical and physiologicalstudies
- Studies on effect of osmotic and ionic stress on seed germination and seedling growth
- Measurement of low temperature injury under field conditions

Suggested Readings

Baker FWG.1989. Drought Resistance in Cereals. Oxon, UK.

Gupta U.S. (Ed.). 1988. Physiological Aspects of Dryland Farming. Oxford & IBH.

Kramer PJ.1983. Water Relations of Plants. Academic Press.

Levitt J. 1980. Response of Plants to Environmental Stresses. Vols. I, II. Academic Press.

Mavi HS.1978. Introduction to Agro-meteorology. Oxford & IBH.

Michael AM &Ojha TP.1981. Principles of Agricultural Engineering. Vol II. Jain Bros.

Nilsen ET &Orcut DM. 1996. Physiology of Plants under Stress – Abiotic Factors. JohnWiley & Sons.

Singh K. 2000. Plant Productivity under Environmental Stress. Agribios.

Singh KN & Singh RP. 1990. Agronomic Research Towards Sustainable Agriculture. Indian Society of Agronomy, New Delhi.

Somani LL & Totawat KL. 1992. Management of Salt-affected Soils and Waters. Agrotech Publ.

Virmani SM, Katyal JC, Eswaran H &Abrol IP.1994. Stressed Ecosystem and Sustainable Agriculture. Oxford & IBH.

Minor subject:

Soil Science and Agro-meteorology are the common subjects taken as minor. The M.Sc. courses of these subjects will complete the requirement of minor courses as decided by the advisory committee of the student and approved by the HOD/ Dean.

Supporting subject:

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
STAT 512	11060203	EXPERIMENTAL DESIGNS	3(2+1)
STAT 513	11060308	SAMPLING TECHNIQUES	3(2+1)

11060203: EXPERIMENTAL DESIGNS 3(2+1)

Objective

This course is meant for students of agricultural and other related sciences. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

UNIT-I

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

UNIT-II

Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

UNIT-III

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

UNIT-IV

Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, Lattice design, Response surfaces.

UNIT-V

Bioassays- direct and indirect, potency estimation.

Practical

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Fitting of response surfaces and Bioassays.

Suggested Readings

- Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley. Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer. Federer WT. 1985. Experimental Designs. MacMillan.
- Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
- Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publication
- Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
- Design Resources Server: www.iasri.res.in /design.

11060308: SAMPLING TECHNIQUES 3(2+1)

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. The students would be exposed to elementary sampling techniques. It would help them in understanding the concepts

involved in planning and designing their surveys, presentation of survey data analysis of survey data and presentation of results. This course would be especially important to the students of social sciences.

Theory

UNIT-I

Concept of sampling, sample survey vs complete enumeration, planning of sample survey, sampling from a finite population.

UNIT-II

Simple random sampling, sampling for proportion, determination of sample size; inverse sampling, Stratified sampling.

UNIT-III

Cluster sampling, PPS sampling, Multi-stage sampling, double sampling, systematic sampling; Use of auxiliary information at estimation as well as selection stages.

UNIT-IV

Ratio and regression estimators. Construction and analysis of survey designs, sampling and non-sampling errors; Preparation of questionnaire Non-sampling errors.

Practical

Random sampling ~ use of random number tables, concepts of unbiasedness, variance, etc.; simple random sampling, determination of sample size; Exercises on inverse sampling, stratified sampling, cluster sampling and systematic sampling; Estimation using ratio and regression estimators; Estimation using multistage design, double sampling and PPS sampling.

Suggested Readings

- Cochran WG. 1977. Sampling Techniques. John Wiley.
- Murthy MN. 1977. Sampling Theory and Methods. 2nd Ed. Statistical Publ. Soc., Calcutta.
- Singh D, Singh P & Kumar P. 1982. Handbook on Sampling Methods. IASRI Publ.
- Sukhatme PV, Sukhatme BV, Sukhatme S & Asok C. 1984. Sampling Theory of Surveys with Applications. Iowa State University Press and Indian Society of Agricultural Statistics, New Delhi.

List of Journals

- Advances in Agronomy
- Agricultural Systems
- Agricultural Water Management
- Agriculture, Ecosystems and Environment
- Agronomy Journal
- Annual Review of Plant Physiology
- Applied Ecology and Environment Research
- Australian Journal of Experimental Agriculture
- Crop Protection
- Environment and Ecology
- European Journal of Agronomy
- Fertilizer Research
- Field Crops Research
- Indian Journal of Agricultural Sciences
- Indian Journal of Agronomy
- Indian Journal of Weed Science
- Irrigation Science
- Japanese Journal of Tropical Agriculture

- Journal of Agricultural Science Cambridge
- Journal of Agronomy
- Journal of Applied Ecology
- Journal of Farming Systems Research
- Journal of Range Management
- Journal of Sustainable Agriculture
- Nutrient Cycling in Agroecosystems
- Pesticide Biochemistry and Physiology
- Plant and Soil
- Plant Production Science
- Soil and Tillage Research
- Weed Research

Suggested Broad Topics for Master's and Doctoral Research

- Crop diversification under different agricultural situations
- Development of farming systems for marginal, small and other farmers
- Agricultural information at door step/click of mouse
- Farm-specific nutrient management
- Weed management in different cropping/farming systems
- Nutrient studies in different cropping/farming systems
- Biodiversity of farming systems for conservation
- Organic farming systems for different regions
- Modelling for different crop situations
- Conservation agriculture for yield sustainability
- Role of edaphic factors on weeds proliferation and management
- Implications of global warming on weed growth and herbicide behaviour
- Ecological implications of using thresholds for weed management
- Effect of cultivation practices and herbicides on weed flora shift
- GM crops and weed management strategies
- Weed management under reduced moisture regime in major summer/kharif crops

SOIL SCIENCE

Major:

Course Code	Old Code	Course Title	Credits	Semester
11020111*	SOILS 601*	ADVANCES IN SOIL PHYSICS	3+0	II
11020112*	SOILS 602*	ADVANCES IN SOIL FERTILITY	3+0	II
11020113*	SOILS 603*	PHYSICAL CHEMISTRY OF SOILS	2+0	II
11020114*	SOILS 604*	SOIL GENESIS AND MICROPEDOLOGY	2+0	I
11020115*	SOILS 605*	BIOCHEMISTRY OF SOIL ORGANIC MATTER	2+0	I
11020116	SOILS 606	LAND USE PLANNING AND WATERSHED MANAGEMENT	2+0	I
11020108	SOILS 691	DOCTORAL SEMINAR I	1	I, II
11020109	SOILS 692	DOCTORAL SEMINAR II	1	I, II
11020110	SOILS 699	DOCTORAL RESEARCH	45	
		SERVICE COURSE		
11020117	ABM 519	FERTILIZER TECHNOLOGY AND MANAGEMENT	2+0	I

*Compulsory courses.

11020111	**Advances in soil physics**	**3+0**	**Sem- I**

Objective

To provide knowledge of modern concepts in soil physics.

Theory

UNIT-I

Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system.

UNIT-II

Fundamentals of fluid flow, Poiseuilles law, Laplace's equation, Darcy's law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity; limitations of Darcy's law; numerical solution for one dimensional water flow.

UNIT-III

Theories of horizontal and vertical infiltration under different boundary conditions.

UNIT-IV

Movement of salts in soils, models formiscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves.

UNIT-V

Soil air and aeration, mass flow and diffusion processes; thermal properties of soil, heat transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil.

UNIT-VI

Soil crust and clod formation; structural management of puddle drice soils; soil conditioningconcept, soils conditioners-types, characteristics, working principles, significance in agriculture.

UNIT-VII

Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop systems; prediction of evapo-transpiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infra-red thermometer.

Suggested Readings:

Baver LD, Gardner WH & Gardner WR. 1972. Soil Physics. John Wiley & Sons. Hanks and Ascheroft. 1980. Applied Soil Physics. Springer Verlag.

Hillel D. 1980. Applications of Soil Physics. Academic Press. Hillel D. 1980. Environmental Soil Physics. Academic Press.

Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi. Kirkham D & Powers WL. 1972. Advanced Soil Physics. Wiley Interscience.

Lal R & Shukla MK. 2004. Principles of Soil Physics. Marcel Dekker. Oswal MC. 1994. Soil Physics. Oxford & IBH.

11020112	**Advances in soil fertility**	**3+0**	**Sem- I**

Objective

To provide knowledge of modern concepts of soil fertility and nutrient use in crop production.

Theory

UNIT-I

Modern concepts of nutrient availability; soil solution and plant growth; nutrient response functions and availability indices.

UNIT-II

Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.

UNIT-III

Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged soils.

UNIT-IV

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

UNIT-V

Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.

UNIT-VI

Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

Suggested Readings:

Barber SA. 1995. Soil Nutrient Bioavailability. John Wiley & Sons.

Barker V Allen & Pilbeam David J. 2007. Handbook of Plant Nutrition. CRC/Taylor & Francis.

Brady NC & Weil RR. 2002. The Nature and Properties of Soils. 13thEd. Pearson Educ. Cooke GW. 1979. The Control of Soil Fertility. Crossby Lockwood & Sons.

Epstein E. 1987. Mineral Nutrition of Plants-Principles and Perspectives. International Potash Institute, Switzerland.

Kabata Pendias Alina 2001. Trace Elements in Soils and Plants. CRC/Taylor & Francis. Kannaiyan S, Kumar K & Govindarajan K.2004. Biofertilizers Technology. Scientific Publ.

Mortvedt JJ, Shuman LM, Cox FR & Welch RM. (Eds.). 1991. Micronutrients in Agriculture. 2ndEd. Soil Science Society of America, Madison.

Prasad R & Power JF. 1997. Soil Fertility Management for Sustainable Agriculture. CRC Press.

Stevenson FJ & Cole MA. 1999. Cycles of Soil: Carbon, Nitrogen Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.

Stevenson FJ. (Ed.). 1982. Nitrogen in Agricultural Soils. Soil Science Society of America, Madison.

Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1990. Soil Fertility and Fertilizers. 5th Ed. Macmillan Publ.

Wild A. (Ed.). 1988. Russell's Soil Conditions and Plant Growth. 11thEd. Longman.

11020113	Physical chemistry of soils	2+0	Sem- I

Objective

To impart knowledge about modern concepts of physical chemistry of soils and clays, with emphasis on understanding the processes involved with practical significance.

Theory

UNIT-I

Colloidal chemistry of inorganic and organic components of soils-their formation, clay organic interaction.

UNIT-II

Predictive approaches for cation exchange equilibria-thermodynamics,empirical and diffuse double layer theory(DDL)-relationships among different selectivity coefficients; structure and properties of diffuse double layer.

UNIT-III

Thermodynamics of nutrient transformations in soils; cationic and anionic exchange and their models, molecular interaction.

UNIT-IV

Adsorption/desorption isotherms - Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).

UNIT-V

Common solubility equilibria-carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electro-chemical properties of clays (citation of examples from agricultural use).

Suggested Readings:

Stevenson FJ & Cole MA. 1999. Cycles of Soil:Carbon, Nitrogen Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.

Stevenson FJ. (Ed.). 1982. Nitrogen in Agricultural Soils. Soil Science Society of America, Madison.

Bear RE. 1964. Chemistry of the Soil. Oxford & IBH.

Bolt GH & Bruggenwert MGM. 1978. Soil Chemistry. Elsevier.

Fried M & Broeshart H. 1967. Soil Plant System in Relation to Inorganic Nutrition. Academic Press.

Greenland DJ & Hayes MHB. 1981. Chemistry of Soil Processes. John Wiley & Sons.

Greenland DJ & Hayes MHB. 1978. Chemistry of Soil Constituents. John Wiley & Sons.

Jurinak JJ. 1978. Chemistry of Aquatic Systems. Dept. Of Soil Science & Biometeorology, Utah State Univ.

McBride MB. 1994. Environmental Chemistry of Soils. Oxford Univ. Press.

Sparks DL. 1999. Soil Physical Chemistry. 2nd Ed. CRC Press.

Sposito G. 1981. The Thermodynamics of Soil Solutions. Oxford Univ. Press.

Sposito G. 1984. The Surface Chemistry of Soils. Oxford Univ.

Press. Sposito G. 1989. The Chemistry of Soils. Oxford Univ. Press.

Stevenson FJ. 1994. Humus Chemistry. 2nd Ed. John Wiley.

VanOlphan H. 1977. Introduction to Clay Colloid Chemistry. John Wiley & Sons.

11020114	**Soil genesis & micro-pedology**	**2+0**	**Sem-II**

Objective

To impart knowledge about the pedogenic processes in soils and to acquaint with the micro-pedological study of soil profile.

Theory

UNIT-I

Pedogenic evolution of soils; soil composition and characterization.

UNIT-II

Weathering and soil formation – factors and pedogenic processes; stability and weathering sequences of minerals.

UNIT-III

Assessment of soil profile development by mineralogical and chemical analysis.

UNIT-IV

Micro-pedological features of soils – their structure, fabric analysis, role in genesis and classification.

SuggestedReadings:

Boul SW, Hole ED, MacCraken RJ & Southard RJ. 1997. Soil Genesis and Classification. 4th Ed. Panima Publ.

Brewer R. 1976. Fabric and Mineral Analysis of Soils. John Wiley & Sons.

11020115	Biochemistry of soil organic matter	2+0	Sem -I

Objective

To impart knowledge related to chemistry and reactions of organic substances and their significance in soils.

Theory

UNIT-I

Organic matter pools in soil; composition and distribution of organic matter in soil and its functions; environmental significance of humic substances; decomposition of organic residues in soil in relation to organic matter pools.

UNIT-II

Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.

UNIT-II

Nutrient transformation – N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils.

UNIT-V

Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; lay-organic matter complexes.

UNIT-V

Humus-pesticide interactions in soil, mechanisms.

Suggested Readings

Beck AJ, Jones KC, Hayes MHB & Mingelgrin U. 1993. Organic Substances in Soil and Water: Natural Constituents and their 104 Influences on Contaminant Behavior. Royal Society of Chemistry, London.

Gieseking JE. 1975. Soil Components.Vol.1. Organic Components. Springer-Verlag.

Kristiansen P, Taji A & Reganold J. 2006. Organic Agriculture: A Global Perspective. CSIRO Publ.

Magdoff F & Weil RR 2004. Soil Organic Matter in Sustainable Agriculture. CRC Press.

Mercky R & Mulongoy K. 1991. Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture. John Wiley & Sons.

Paul EA. 1996. Soil Microbiology and Biochemistry. Academic Press.

Stevenson FJ. 1994. Humus Chemistry–Genesis, Composition and Reactions. John Wiley & Sons.

Stevenson FJ. 1994. Humus Chemistry–Genesis, Composition and Reactions. John Wiley & Sons.

11020116	Land use planning and watershed management	2+0	Sem - I

Objective

To teach the better utilization of land for agricultural purposes, and better management of run-off or surplus/ excessive rain-water in the catchment area for agricultural purposes in a watershed.

Theory

UNIT-I

Concept and techniques of land use planning; factors governing present land use.

UNIT-II

Land evaluation methods and soil-site suitability evaluation for different crops; land capability classification and constraints in application.

UNIT-II

Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production.

UNIT-IV

Water harvesting - concept, significance, types, methodology; use of harvested water in agriculture to increase water productivity.

UNIT-V

Watershed development/ management-concept, objectives, characterization, planning, execution, community participation and evaluation; rehabilitation of watershed; PRA; developing economically and ecologically sustainable agro-forestry.

SuggestedReadings:

All India Soil and Land Use Survey Organisation 1970. Soil Survey Manual. IARI, New Delhi.

FAO.1976.A Framework for Land Evaluation, Handbook 32. FAO.

Sehgal JL, Mandal DK, Mandal C & Vadivelu S.1990. Agro-Ecological Regions of India. NBSS & LUP, Nagpur.

Soil Survey Staff 1998. Keysto Soil Taxonomy. 8th Ed. USDA & NRCS, Washington, DC.

USDA 1974. A Manual on Conservation of Soil and Water Handbook of Professional Agricultural Workers. Oxford & IBH.

Minor subject:

Agronomy may be taken as minor subject as decided by the advisory committee of the student after the approval of HOD/Dean. However, other subjects may be taken as minor depending on the requirement of research problem.

Supporting subject:

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
STAT 512	11060203	EXPERIMENTAL DESIGNS	3(2+1)
STAT 513	11060308	SAMPLING TECHNIQUES	3(2+1)

*Syllabus is provided elsewhere in the ordinance.

HORTICULTURE

Major:

Course Code	Old Code	Course Title	Credits	Semester
11020118*	FSC 601*	ADVANCES IN BREEDING OF FRUIT CROPS	2+1	II
11020119*	FSC 602*	ADVANCES IN PRODUCTION OF FRUIT CROPS	2+1	I
11020120	FSC 603	ADVANCES IN GROWTH REGULATION OF FRUIT CROPS	2+1	II
11020121	FSC 605	BIOTIC AND ABIOTIC STRESS MANAGEMENT INHORTICULTURAL CROPS	2+1	I
11020122	FSC 604	INTRODUCTION TO BIOINFORMATICS	2+1	I
11020108	FSC 691	DOCTORAL SEMINAR I	1	I, II
11020109	FSC 692	DOCTORAL SEMINAR II	1	I, II
11020110	FSC 699	DOCTORAL RESEARCH	45	

*Compulsory courses.

11020118	**Advances in breeding of fruit crops**	**2+1**	**Sem- II**

Objective

To update knowledge on the recent research trends in the field of breeding of fruit crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

Evolutionary mechanisms, adaptation and domestication, Genetic resources, cytogenetics, cytomorphology, chemotaxonomy, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits , recent advances in crop improvement efforts- introduction and selection, chimeras, apomixis, clonal selections, intergeneric, interspecific and intervarietal hybridization, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, molecular and transgenic approaches in improvement of selected fruit crops.

Crops

UNIT-I: Mango and banana
UNIT-II: Papaya, grapes and citrus
UNIT-III: Guava and sapota
UNIT-IV: Pineapple and avocado
UNIT-V: Apple, pear, plums, peaches, apricot, cherries and strawberry

Practical

Description and cataloguing of germplasm, pollen viability tests, pollen germination isozyme techniques-survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagenes and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding fruit crops.

Suggested Readings

Bose TK, Mitra SK &Sanyol D. (Ed.). 2002. Fruits of India – Tropical and Sub-tropical.3rd Ed. Vols. I, II. Naya Udyog.

Chadha KL &Pareek OP. (Eds.). 1996. Advances in Horticulture. Vol. I.Malhotra Publ. House.

Chadha KL &Shikhamany SD. 1999. The Grape: Improvement, Production and Post-Harvest Management. Malhotra Publ. House.

Gowen S. 1996. Banana and Plantains. Chapman & Hall.

Janick J & Moore JN. 1996. Fruit Breeding. Vols.I-III. John Wiley & Sons.

Nijjar GS. (Ed.). 1977. Fruit Breeding in India. Oxford & IBH.

Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. Advances in Citriculture.Jagmander Book Agency.

Stover RH & Simmonds NW. 1991. Bananas. Longman.

11020119	**Advances in production of fruit crops**	**2+1**	**Sem - I**

Objective

To keep abreast with latest developments and trends in production technology of fruit crops.

Theory

National and International scenario in fruit production, Recent advances in propagation -root stock influence, planting systems, High density planting, crop modeling , Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to240overcome stress effects, integrated and modern approaches in water and nutrient management, , Total quality management(TQM) - Current topics.

Crops

UNIT-I : Mango and banana
UNIT-II: Papaya, grapes and citrus
UNIT-III: Guava, sapota and aonla
UNIT-IV: Pineapple, avocado and jack
UNIT-V: Apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Practical

Survey of existing fruit cropping systems and development of a model cropping system, Estimating nutrient deficiency- estimation of water use efficiency, soil test-crop response correlations, practices in plant growth regulation, studying physiological and biochemical responses, quality analysis.

Suggested Readings

Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. Temperate Fruits – Horticulture. Allied Publ.

Bose TK, Mitra SK &Sanyal D. (Eds.). 2001. Fruits -Tropical and Subtropical. NayaUdyog.

Bose TK, Mitra SK, Farooqi AA & Sadhu MK. 1999. Tropical Horticulture. Vol. I. Naya Prokash.

Chadha KL &Pareek OP. (Eds.).1996. Advances in Horticulture. Vols. II-IV. Malhotra Publishing House.

Chadha KL. 2001. Handbook of Horticulture. ICAR.

Nakasone HY & Paull RE. 1998. Tropical Fruits. CABI.

Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.

11020120	Advances in growth regulation of fruit crops	2+1	Sem - II

Objective
Appraisal on the advances in growth regulation of fruit crops.

Theory
UNIT-I: Ecophysiological influences on growth and development of fruit crops flowering, fruit set- Crop load and assimilate partitioning and distribution.
UNIT-II: Root and canopy regulation, study of plant growth regulators in fruit culture structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants.
UNIT-III: Absorption, translocation and degradation of phyto-hormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards.
UNIT-IV: Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production.
UNIT-V: Flower drop and thinning, fruit set and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation current topics.

Practical
Root- shoot studies, quantifying the physiological and biochemical effects of physical and chemical growth regulation, bioassay and isolation through chromatographic analysis for auxins, gibberellins, experiments on growth regulation during propagation, dormancy, flowering, fruit set and fruit development stages.

Suggested Readings
Buchanan B, Gruiessam W & Jones R. 2002. Biochemistry & Molecular Biology ofPlants. John Wiley & Sons.

Epstein E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. Wiley.

Fosket DE. 1994. Plant Growth and Development: A Molecular Approach. Academic Press.

Leoplod AC &Kriedermann PE. 1985. Plant Growth and Development. 3rd Ed. McGraw-Hill.

Radha T & Mathew L. 2007. Fruit Crops. New India Publ. Agency.

Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: Plants (I. Ridge, Ed.), pp. 221-274, Oxford University Press.241

Salisbury FB & Ross CW. 1992. Plant Physiology. 4th Ed. Wadsworth Publ.

11020121	Introduction to bioinformatics	2+1	Sem- I

Objective
To impart an introductory knowledge about the subject of Bioinformatics to the studentsstudying any discipline of science.

Theory
UNIT-I: Introduction, biological databases - primary, secondary and structural, Protein and Gene Information Resources - PIR, SWISSPROT, PDB, Gene Bank, DDBJ. Specialized genomic resources.
UNIT-II: DNA sequence analysis, cDNA libraries and EST, EST analysis, pair wise alignment techniques, database searching, multiple sequence alignment.
UNIT-III: Secondary database searching, building search protocol, computer aided drug design - basic principles, docking, QSAR.

UNIT-IV: Analysis packages - commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical

- Usage of NCBI resources
- Retrieval of sequence/structure from databases
- Visualization of structures
- Docking of ligand receptors
- BLAST exercises.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. Introduction to Bioinformatics. Pearson Edu.

Rastogi SC, Mendiratta N & Rastogi P. 2004. Bioinformatics: Concepts, Skills and Applications. CBS.

11020122	**Biotic & abiotic stress management in horticultural crops**	**2+1**	**Sem- I**

Objective

To update knowledge on the recent research trends in the field of biotic and abiotic stress management in horticultural crops.

Theory

UNIT-I: Stress – definition, classification, stresses due to water (high and low),temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.).

UNIT-II: Pollution - increased level of CO2, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations.

UNIT-III: Crop modeling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stress and their impact on crop growth and productivity.

UNIT-IV: Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers.

UNIT-V: Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

Practical

Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors, RWC, chlorophyll flurosence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and water shed locations.

Suggested Readings

Blum A. 1988. Plant Breeding for Stress Environments. CRC.

Christiansen MN & Lewis CF. 1982. Breeding Plants for Less Favourable Environments.Wiley Inter. Science.

Hsiao TC. 1973. Plant Responses to Water Stress. Ann. Rev. Plant Physiology 24: 519-570.

Kramer PJ. 1980. Drought Stress and the Origin of Adaptation. In: Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons.

Levitt J. 1972. Response of Plants to Environmental Stresses. Academic Press.
Maloo SR. 2003. Abiotic Stress and Crop Productivity. Agrotech Publ. Academy.
Mussell H & Staples R. 1979. Stress Physiology in Crop Plants. Wiley Inter. Science.
Nickell LG. 1983. Plant Growth Regulating Chemicals. CRC.
Peter KV. (Ed.). 2008. Basics of Horticulture. New India Publ. Agency.
Turener NC & Kramer PJ. 1980. Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons.

Minor subject:

ICAR CODE	CODE	COURSE TITLE	CREDITS
VSC 504	11060213	GROWTH AND DEVELOPMENT OF VEGETABLE CROPS	2+1
VSC 505	11060401	SEED PRODUCTION IN VEGETABLE CROPS	2+1
VSC 507	11060113	PRODUCTION TECHNOLOGY OF UNDER EXPLOITED VEGETABLE CROPS	1+1
VSC 508	11060310	ORGANIC VEGETABLE PRODUCTION TECHNOLOGY	1+1
VSC 509	11060309	FUNDAMENTALS OF PROCESSING OF VEGETABLES	2+1

*Syllabus available in M.Sc. ordinance

Supporting subject:

Course Code (ICAR pattern)	Course Code (SGTU pattern)	Course Title	Credits
STAT 512	11060203	EXPERIMENTAL DESIGNS	3(2+1)
STAT 513	11060308	SAMPLING TECHNIQUES	3(2+1)

*Syllabus is provided elsewhere in the ordinance.

List of Journals & Magazines

- Replant problems in perennial fruit crops Acta Horticulture
- Haryana Journal of Horticulture Science
- Horticulture Reviews
- HortScience
- Indian Horticulture
- Indian Journal of Arid Horticulture
- Indian Journal of Horticulture
- Journal of American Society of Horticultural Sciences
- Journal of Applied Horticulture
- Journal of Horticultural Sciences
- Journal of Horticultural Sciences & Biotechnology
- Journal of Japanese Society for Horticulture Science
- Journal of Korean Society for Horticulture Science
- Scientia Horticulture
- South Indian Horticulture

Suggested Broad Topics for Master's and Doctoral Research

- Micro-propagation of fruit crops
- Application of genetic engineering in fruit crops
- Use of molecular markers in fruit crops
- Fruit crop improvement
- Crop selection for biotic and abiotic stresses
- Diagnostic and recommended integrated system in cultivation of fruit crops
- Precision farming in fruit crops
- Protected cultivation of fruit crops
- Root distribution studies in fruit crops
- Canopy management in fruit crops
- Organic fruit cultivation
- Post harvest management of fruit crops
- Value addition in fruit crops
- Rejuvenation of orchards

GENETICS AND PLANT BREEDING

Major courses:

Course Code	Old Code	Course Title	Credits	Semester
11020123	GP 601	ADVANCED GENETICS	2+0	I
11020124	GP 602	CELLULAR AND CHROMOSOMAL MANIPULATIONS FOR CROP BREEDING	2+0	II
11020125	GP 603	ADVANCED BIOMETRICAL AND QUANTITATIVE GENETICS	2+1	I
11020126	GP 604	GENOMICS IN PLANT BREEDING	2+1	II
11020127	GP 605	PLANT GENETIC RESOURCES AND PRE-BREEDING	2+0	I
11020128	GP 606	ADVANCES IN PLANT BREEDING SYSTEMS	2+0	II
11020129	GP 607	CROP-EVOLUTION	2+0	I
11020130	GP 608*	BREEDING DESIGNER CROPS	2+1	II
11020131	GP 609*	ADVANCES IN BREEDING OF MAJOR FIELD CROPS	3+0	I
11020132	GP610/ SST 602	IN SITU AND EX SITU CONSERVATION OF GERMPLASM	2 +1	II
11020133	GP 611	MICROBIAL GENETICS	2+1	I
11020134	GP 612/ PSMA 605	ADVANCES IN BREEDING OF MEDICINAL AND AROMATIC CROPS	2+1	II
11020108	GP 691	DOCTORAL SEMINAR I	1	I, II
11020109	GP 692	DOCTORAL SEMINAR II	1	I, II
11020110	GP 699	DOCTORAL RESEARCH	45	I, II

*Compulsory courses.

11020123	**ADVANCED GENETICS**	**2+0**	**Sem- I**

Objective

To acquaint the students about the recent advances in the field of general genetics.

Theory

UNIT-I: Gene regulation in prokaryotes- Lac operon; Gal operon; Arabinose operon, Tryp operon; Repressor versus attenuation; Regulation of lytic and lysogenic phages; Gene regulation in eukaryotes; Genetic control of antibody diversity.

UNIT-II: Regulatory units in yeast; Mechanisms of genetic recombination; Illegitimate and site specific recombination, flagellar antigen switching in Salmonella; mating type switching in S. cerevisiae, Polymorphism; Methods of studying polymorphism at biochemical and DNA level; Genetics of mitochondria and chloroplasts; Discussion on complex loci with reference to gene concept, Discussion on recent topics in the field of genetics**.**

Suggested Readings

Lewin B. 2008. Genes IX. Jones & Bartlett Publ.

11020124	**CELLULAR AND CHROMOSOMAL MANIPULATIONS FOR CROP BREEDING**	**2+0**	**Sem- II**

Objective

This course focuses on the advanced techniques in analyzing chromosome structure and manipulations for genome analysis in crop species.

Theory

UNIT-I: Organization and structure of genome – Genome size – Organization of organellar genomes – Nuclear DNA organization – Nuclear and Cytoplasmic genome interactions and signal transduction, Transcriptional and Translational changes, Inheritance and expression of organellar DNA; Variation in DNA content – C – value paradox – sequence complexity – Introns and Exons – Repetitive sequences – Role of repetitive sequence in crop evolution.

UNIT-II: Karyotyping – Chromosome banding and chromosome painting Tracking introgressions using FISH, GISH, loclalization and mapping of genes/genomic segments. – Distant hybridization - Role of polyploids in crop evolution and breeding - auto and allopolyploids.

UNIT-III: Applications of cytogenetical methods for crop improvement; location and mapping of genes on chromosomes: deficiency method; interchange-genetic consequence, identification of chromosomes involved and gene location; balanced lethal systems, their maintenance and utility; multiple interchanges-use in producing inbreds, transfer of genes linked marker methods; Duplication - production and use; inversions and location of genes; B/A chromosome translocations and gene location.

UNIT-IV: Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics-methods of production, breeding behavior and location of genes; Intervarietal substitutions-allelic an non-allelic interactgions, telocentric method of mapping.

UNIT-V: Barriers to interspecific and intergeneric hybridization, Behaviour of interspecific and intergeneric crosses – Totipotency of cells – Morphogenesis: in vivo and in vitro – Meristem culture – anther and pollen culture – ovule, ovary, embryo and endosperm culture – protoplast isolation and culture – protoplast fusion, Different pathways of in vitro morphogenesis – organogenesis and somatic embryogenesis – In vitromutant/somaclone selection for biotic and abiotic stresses.

Suggested Readings

Clark MS & Wall WJ. 1996. Chromosomes: The Complex Code. Chapman & Hall.

Conger BV. (Ed.). 1981. Cloning Agricultural Plants via in vitro Techniques. CRC Press.

Constabel F & Vasil IK. (Eds.). 1988. Cell Culture and Somatic Cell Genetics of Plants. Vol. V. Cell Culture and Phytochemicals in Plant Cell Cultures. Academic Press.

Lal R & Lal S. (Eds.). 1990. Crop Improvement Utilizing Biotechnology. CRC Press.

Mantel SH & Smith H. 1983. Plant Biotechnology. Cambridge University Press.

Sen SK & Giles KL. (Eds.). 1983. Plant Cell Culture in Crop Improvement. Plenum Press.

11020125	**ADVANCED BIOMETRICAL AND QUANTITATIVE GENETICS**	**2+1**	**Sem- I**

Objective

Knowledge and computation methods for non allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

UNIT-I: Basic principles of Biometrical Genetics - selection of parents - Advanced biometrical models for combining ability analysis -Simultaneous selection models; Use of Multiple regression analysis in selection of genotypes; Designs and Systems - Selection of stable genotypes.

UNIT-II: Models in stability analysis - Pattern analysis - Additive Main Effect and Multiplicative Interaction (AMMI) model and other related models - Principal Component Analysis model.

UNIT-III: Additive and multiplicative model - Shifted multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Biplots and mapping genotypes.

UNIT-IV: Genetic architecture of quantitative traits - conventional analyses to detect gene actions - Partitioning of phenotypic/genotypic variance - Construction of saturated linkage maps, concept of framework map development, QTL mapping; Strategies for QTL mapping - desired populations , - statistical methods , : Marker Assisted Selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - Factors influencing MAS: heritability of the trait, proportion of genetic variance, linkage disequilibrium between markers and traits and selection methods.

Practical

Working out efficiency of selection methods in different population and interpretation -Biparental mating – use of softwares in analysis and result interpretation - Triallel analysis– use of softwares in analysis and result interpretation - Quadriallel analysis – use of softwares in analysis and result interpretation - Triple Test Cross (TTC) – use of softwares in analysis and result interpretation - Advanced biometrical models for combining ability analysis - Selection of stable genotypes using stability analysis; Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model -Principal Component Analysis model - Additive and multiplicative model - Shifted multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes. Construction of linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies.

Suggested Readings

Bos I & P Caligari. 1995. Selection Methods in Plant Breeding. Chapman & Hall. Falconer DS. 1983. Problems on Quantitative Genetics. Longman.Falconer DS. 1998. Introduction to Quantitative Genetics. Longman.

Mather K & Jinks L. 1983. Introduction to Biometrical Genetics. Chapman & Hall.

Nadarajan N & Gunasekaran M. 2005. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani.

Singh P & Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani.

Singh RK & Choudhary BD. 1987. Biometrical Methods in Quantitative Genetics. Kalyani.Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.

Wricke G & Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding.
Walter de Gruyter.

11020126	GENOMICS IN PLANT BREEDING	2+1	Sem- II

Objective

To impart practical skills in advanced molecular techniques in genome mapping and development of transgenic crops.

Theory

UNIT-I: Introduction to the plant genome- Plant genomes and their molecular description - The chloroplast and the mitochondrial genomes in plants - Genome size and complexity.

UNIT-II: Establishment of plant genome mapping projects - Genome mapping and use of molecular markers in plant breeding – Strategies for mapping genes of agronomic traits in plants- Approaches for mapping quantitative trait loci- Map based cloning of plant genes.

UNIT-III: Functional genomics- Regulation of Plant gene expression – Expression Analysis using Microarrays – Transposon tagging and Insertional mutagenesis- methods and significance- Diversity Array Technology.

UNIT-IV: Genome sequencing in plants–Principles and Techniques; Applications of sequence information in plant genome analyses - Comparative genomics–Genome
Comparison Techniques: Classical and advanced approaches.

UNIT-V: Detection of Single Nucleotide Polymorphism–TILLING and Eco-TILLING –

Role of transcriptomics, proteomics and metabolomics in linking genome and phenome, Importance of understanding the phenotypes for exploiting the outcome of genomic technologies- Knock out studies and high throughput phenotyping.

UNIT-VI: Concept of database development, management and bioinformatics Plant genome projects and application of bioinformatics tools in structural and functional genomics.

Practical

Chromosome analysis in major field crops - Fluorescence in situ hybridization -Comparative genomic hybridization – Comparative analysis of plant genomes using molecular markers – Genetic map construction using molecular markers – Mapping major genes using molecular markers – QTL mapping in plants – Comparison across mapping populations – Understanding the need genetic algorithms in QTL mapping – Plant Genome Databases – Computational tools to explore plant genome databases –

Comparative genomics – Comparison of genome sequences using tools of bioinformatics, Advanced genomic technologies: TILLING and Eco-TILLING – DNA Array Technology

– Linking genome sequences to phenotypes: Tools of transcriptomics, proteomics and metabolomics.

Suggested Readings

Baxevanis AD & Ouellette BFF. 2001. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley Interscience.

Brown TA. 2002. Genomes. Wiley-LISS. Caetano-Anolles G & Gresshoff PM. 1998. DNA Markers: Protocols, Applications and Overviews. Wiley-VCH.

Cantor CR & Smith CL (2004). Genomics. Wiley.Galas DJ & McCormack SJ. 2002. Genomic Technologies: Present and Future. Calster Academic Press.

11020127	**PLANT GENETIC RESOURCES AND PRE-BREEDING**	**2+0**	**Sem- I**

Objective

To provide information about collection, maintenance and use of plant genetic resources for crop improvement.

Theory

UNIT-Il: Historical perspectives and need for PGR conservation, importance of plant genetic resources, taxonomical classification of cultivated plants, Gene pool: primary, secondary and tertiary; Centres of origin and global pattern of diversity; basic genetic resources and transgenes.

UNIT-II: Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR; Plant quarantine and phytosanitary certification; Germplasm, introduction and exchange; principles of in vitro and cryopreservation.

UNIT-III: Germplasm conservation- in situ, ex situ, and on-farm; short, medium and long term conservation strategies for conservation of orthodox seed and vegetatively propagated crops; registration of plant genetic resources.

UNIT-IV: PGR data base management, multivariate and clustering analysis, description, national and international protocols for PGR management, PGR for food and agriculture (PGRFA), PGR access and benefit sharing. Role of CGIR system in the germplasm exchange; PBR, Farmers rights and privileges. Seed act, sui generis system; geographical indicators, Intellectual property; patents, copyrights, trademarks and trade secrets.

UNIT-V: Journey from wild to domesticate; Genetic enhancement; need for genetic enhancement. Genetic enhancement in pre era and 21st century; Genetic enhancement and plant breeding; reasons for failure in genetic enhancement; Sources of genes/ traits- novel genes for quality.

UNIT-VI: Distant Hybridization: Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer tools and techniques into cultivated species; Validation of transferred genes and their expression.

UNIT-VII: Post-genomic tools for genetic enhancement of germplasm; pre-breeding through chromosome manipulation-Application of biotechnology for Genetic enhancement-Achievements.
UNIT-VIII: Utilization of genetic resources, concept of core and mini-core collections, genetic enchancement/Prebreeding for crop improvement including hybrid development.

Suggested Readings

Franckel OH & Bennett E. 1970. Genetic Resources in Plants – their Exploration and Conservation. Blackwell.
Gautam PL, Dass BS, Srivastava U & Duhoon SS. 1998. Plant Germplasm Collecting: Principles and Procedures. NBPGR, New Delhi.
Painting KA, Perry MC, Denning RA & Ayad WG. 1993. Guide Book for Genetic Resources Documentation. IPGRI, Rome, Italy.
Paroda RS & Arora RK. 1991. Plant Genetic Resources, Conservation and Management, Concepts and Approaches. IBPFR Regional office for South and South Asia, New Delhi.

11020128	ADVANCES IN PLANT BREEDING SYSTEMS	2+0	Sem-II

Objective

To impart theoretical knowledge and computation methods for non allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

UNIT-I: Facts about plant breeding before the discovery of Mendelism; evolutionary concepts of genetics and plant breeding - Flower development and its importance- genes governing the whorls formation and various models proposed - Mating systems and their exploitation in crop breeding; Types of pollination - Mechanisms promoting cross pollination.
UNIT-II: Self-incompatability and sterility – Types of self incompatability: Homomorphic (sporophytic and gametophytic) and heteromorphic - Breakdown of incompatibility -Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self incompatibility - Sterility: male and female sterility – Types of male sterility: genic, cytoplasmic and cytoplasmic-genic; exploitation in monocots and dicots - Difficulties in exploiting CGMS system in dicots – case studies and breeding strategies -Nucleocytoplasmic interactions with special reference to male sterility –Genetic , biochemical and molecular bases.
UNIT-III: Population formation by hybridization - Types of population - Mendelian population, gene pool, composites, synthetics etc. Principles and procedures in the formation of a complex population - Genetic basis of population improvement.
UNIT-IV: Selection in self fertilizing crops: Creation of genetic variability selection methods - Selection methods: mass selection, pureline selection, pedigree method (selection in early generations vs advanced generations); backcross, polycross and test cross.
UNIT-V: Selection in cross fertilizing crops – Polycross and top cross selections, Mass and recurrent selection methods and their modifications - Mass selection: grided mass selection, ear to row selection, modified ear to row selection, convergent selection, divergent selection - Recurrent selection: Simple recurrent selection and its modifications (restricted phenotypic selection, selfed progeny selection and full sib recurrent selection) -Recurrent selection for general combining ability (GCA) – concepts and utilization -Recurrent selection for specific combining ability (SCA) – usefulness in hybrid breeding programmes - Reciprocal recurrent selection (Half sib reciprocal recurrent selection, Half sib reciprocal recurrent selection with inbred tester and Full sib reciprocal recurrent selection) – Selection in clonally propagated crops – assumptions and realities.
UNIT-VI: Genetic engineering technologies to create male sterility ; prospects and problems - Use of self- incompatability and sterility in plant breeding – case studies; -Fertility restoration in male sterile lines and restorer diversification programmes -Conversion of agronomically ideal genotypes into male steriles – concepts and breeding strategies; case studies - Generating new

cytonuclear interaction system for diversification of male steriles - Stability of male sterile lines – Environmental influence on sterility–Environmentally Induced Genic Male Sterility (EGMS) - Types of EGMS ; influence on their expression; genetic studies – Photo and thermo sensitive genetic male sterility and its use in heterosis breeding - Temperature sensitive genetic Male sterility and its use heterosis breeding - Apomixis and its use in heterosis breeding - Incongruity - Factors
influencing incongruity - Methods to overcome incongruity mechanisms.

Suggested Readings

Agarwal RL. 1996. Fundamentals of Plant Breeding and Hybrid Seed Production. Oxford & IBH.
Allard RW. 1966. Principles of Plant Breeding. John Wiley & Sons.
Briggs FN & Knowles PF. 1967. Introduction to Plant Breeding. Reinhold.
Fehr WR. 1987. Principles of Cultivar Development: Theory and Technique. Vol I. Macmillan.
Hayes HK, Immer FR & Smith DC. 1955. Methods of Plant Breeding. McGraw-Hill.
Mandal AK, Ganguli PK & Banerji SP. 1995. Advances in Plant Breeding. Vol. I, II. CBS

11020129	CROP EVOLUTION	2+0	Sem-II

Objective

To impart knowledge on crop evolutionary aspects and manipulation at ploidy level for crop improvement.

Theory

UNIT-I: Origin and evolution of species; Centres of diversity/origin, diffused centres; Time and place of domestication; Patterns of evolution and domestication-examples and case studies.

UNIT-II: Domestication and uniformity – Characteristics of early domestication and changes – Concept of gene pools and crop evolution; Selection and Genetic drift -consequences.

UNIT-III: Speciation and domestication – The process of speciation – Reproductive isolation barriers – Genetic differentiation during speciation – Hybridization - speciation and extinction.

UNIT-IV: Exploitation of natural variation – Early attempts to increase variation –Distant hybridization and introgression- Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations; Gene transfer into cultivated species, tools and techniques; Validation of transferred genes and their expression, Controlled introgressions.

UNIT-V: Processes in crop evolution and stabilization of polyploids, cytogenetic and genetic stabilization; Genome organization – Transgenesis in crop evolution –Multifactorial genome – Intragenomic interaction – Intergenomic interaction – Genome introgression.

UNIT-VI: Methods to study crop evolution - Contemporary Methods – Based on morphological features – Cytogenetic analysis – Allozyme variations and crop evolution –DNA markers, genome analysis and comparative genomics.

UNIT-VII: Evolutionary significance of polyploidy, Evolution of crop plants through ploidy manipulations; polyploids: methods, use of autopolyploids; haploidy-method of production and use; allopolyploids- synthesis of new crops; - Case studies – Cereals –Pulses – Oilseeds – vegetables, Fibre crops - Plantation crops – Forage crops – Tuber crops – Medicinal Plants.

Suggested Readings

Hancock JF. 2004. Plant Evolution and the Origin of Crop Species. 2nd Ed. CABI.
Ladizinsky G. 1999. Evolution and Domestication. Springer.
Miller AJ. 2007. Crop Plants: Evolution. John Wiley & Sons.
Smartt J & Simmonds NW. 1995. Evolution of Crop Plants. Blackwell.

11020130	BREEDING DESIGNER CROPS	2+1	Sem-II

Objective

To impart theoretical knowledge and practical know-how towards physiological efficiency, nutritional enhancement, biofortification and industrial/pharma applications in plant breeding.

Theory

UNIT-I: Breeding of crop ideotypes, Genetic manipulations through recombination breeding, genomics and transgenics for physiological efficiency, nutritional enhancement, special compounds-proteins, vaccines, gums, starch and fats.

UNIT-II: Physiological efficiency as a concept, parametric and whole plant physiology in integrated mode. Physiological mechanism of improvement in nutrient use efficiency, water use efficiency, osmotic adjustment, photosynthetic efficiency, stay green trait and its significance in crop improvement.

UNIT-III: Improvement in yield potential under sub optimal conditions by manipulating source and sink, canopy architecture, plant-water relationships, effect of suboptimal conditions on cardinal plant growth and development processes, enhancing input use efficiency through genetic manipulations.

UNIT-IV: Breeding for special traits viz. oil, protein, vitamins, amino acids etc. Concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products; Success stories in vaccines, modified sugars, gums and starch through biopharming.

UNIT-V: Biosafety management, segregation and isolation requirements in designer crop production and post-harvest management.

Practical

Demonstration of plant responses to stresses through recent techniques, water use efficiency, transpiration efficiency, screening techniques under stress conditions such as electrolyte leakage, TTC, chlorophyll fluorescence, canopy temperature depression, stomatal conductance, chlorophyll estimation, heat/drought/salt shock proteins.

Suggested Readings

Balint A. 1984. Physiological Genetics of Agricultural Crops. AK Ademiaikiado.

Hay RK. 2006. Physiology of Crop Yield. 2nd Ed. Blackwell.

Pessarakli M. 1995. Handbook of Plant and Crop Physiology. Marcel Dekker.

Taiz L & Zeiger E. 2006. Plant Physiology. 4th Ed. Sinauer Associates.

11020131	**ADVANCES IN BREEDING OF MAJOR FIELD CROPS**	**3+0**	**Sem-I**

Objective

To provide insight into recent advances in improvement of cereals, millets and non cereal crops using conventional and modern biotechnological approaches.

Theory

UNIT-I: History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species of major cereals, millets and non cereal crops like Rice, Wheat, Maize, Pearlmillet, Sorghum, Pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc.

UNIT-II: Breeding objectives in ; Rice, Wheat, Maize, Pearlmillet, Sorghum, Pulses, oilseeds, cotton, sugarcane, arid legumes and other forage crops etc. Genetic resources and their utilization. Genetics of quantitative and qualitative traits.

UNIT-III: Breeding for Value addition and resistance to abiotic and biotic stresses.

UNIT-IV: Conventional (line breeding, population improvement, hybrids) and other approaches (DH Populations, Marker Assisted Breeding, Development of new male sterility systems), transgenics.

UNIT-V: National and International accomplishments in genetic improvement of major field crops and their seed production.

Suggested Readings

Chopra VL. 2001. Breeding Field Crops - Theory and Practice. Oxford & IBH.

Davis DD.1978. Hybrid Cotton Specific Problems and Potentials. Adv. Agron. 30: 129-157.

Heyne EG. 1987. Wheat and Wheat Improvement. 2nd Ed. ASA, CSSA, SSSA Inc Publ.
Khairwal, I.S Rai,K.N, H.Harinaryanan(Eds). 1999. Pearl Millet Breeding. Oxford & IBH.
Khairwal I, Ram C & Chhabra AK. 1990. Pearl Millet Seed Production and Technology. Manohar Publ.

11020132	**IN SITU AND EX SITU CONSERVATION OF GERMPLASM**	**3+0**	**Sem-I**

Objective

To impart knowledge on the methods of germplasm conservation.

Theory

UNIT-I: Concept of natural reserves and natural gene banks, In situ conservation of wild species in nature reserves: in situ conservation components, factors influencing conservation value, national plan for in situ conservation; in situ conservation of agrobiodiversity on-farm; scientific basis of in situ conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of in situ conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

UNIT-II: Ex situ conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, perma-frost conservation, guidelines for sending seeds to network of active/ working collections, orthodox, recalcitrant seeds- differences in handling , clonal repositories, genetic stability under long term storage condition.

UNIT-III: In vitro storage, maintanence of in vitro culture under different conditions, in-vitro bank maintanence for temporate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems , prospects of in vitro gene bank.

UNIT-IV: Cryopreservation- procedure for handling seeds of orthodox and recalcitrants cryoprotectants, dessication, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation I agriculture, horticulture and forestry crops. Problems and prospects, challenging aheads.

Practical

In situ conservation of wild species –case studies at national and international levels, Ex situ techniques for active and long-term conservation of collections, preparation and handling of materials, packaging, documentation; design of cold storage modules, conservation protocols for recalcitrant and orthodox seeds, cytological studies for assessing genetic stability, vitro cultures-embryo, cell/suspension cultures, pollen cultures, study of cryotank facility and vitrification techniques, visit to NBPGR/NBAGR -study using fruit crops and other horticultural crops.

Suggested Readings

Ellis RH & Roberts EH & White Head J. 1980. A New More Economic and Accurate Approach to Monitor the Viability of Accessions During Storage in Seed Banks. FAO / IBPGR Pl. Genet. Resources News 41-3-18.
Frankel OH & Hawkes JG. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press, Cambridge.
Simmonds, N.W. 1979. Principles of Crop Improvement Longman.
Westwood MN. 1986. Operation Manual for National Clonal Germplasm Repository Processed Report. USDA-ARS and Orgon State Univ. Oregon, USA.
Withers LA. 1980. Tissue Culture Storage for Genetic Conservation. IBPGR Tech. Rep. IBPGR, Rome, Italy.

11020133	MICROBIAL GENETICS	2+1	Sem-I

Objective

The objective of this course is to apprise the students of molecular processes at DNA and RNA level in different microorganisms, especially bacteria and viruses with focus on mutation and repair mechanism, genetics of N2 fixation.

Theory

UNIT-I: Nature of bacterial variation; Molecular aspects of mutation; Episomes and plasmids; Gene mapping in bacteria; Life cycle of bacteriophages; Genetic fine structure analysis of rII locus; Circular genetic map of phage T4; Transposable genetic elements; Biochemical genetics of Neurospora and Saccharomyces ; One gene - one enzyme hypothesis.

UNIT-II: Gene isolation, synthesis and cloning; Genomic and cDNA library; PCR based cloning, positional cloning; Nucleic acid hybridization and immuno-chemical detection; DNA sequencing, DNA restriction and modification , RNA editing; Anti-sense RNA and ribozyme; Synthesis and use of synthetic oligonucleotides.

UNIT-III: Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Molecular chaperones and gene expression; Genetic basis of apoptosis.

UNIT-IV: Transgenic bacteria and bioethics; Gene silencing; Genetic basis of nodulation, nitrogen fixation and competition by rhizobia; Genetic regulation of nitrogen fixation and quorum sensing in rhizobia; Genetics of mitochondria and chloroplasts.

Practical

Preparation and sterilization of liquid and agar bacterial nutrient media; Assessment of generation time in the log-phage bacterial cultures; Handling of microorganisms for genetic experiments; Isolation of rhizobia from nodules; Gram staining of rhizobial cells; Examination of polyhydroxy butyrate (PHB) production in rhizobia; Demonstration of N2-fixing nodules/bacterial inoculation in the legume-Rhizobium symbiotic system; Induction, isolation and characterization of auxotrophic and drug resistant mutants in bacteria; Determination of spontaneous and induced mutation frequencies; Discrete bacterial colony counts for the preparation of survival curves and determination of LD50 of a mutagen; Tn-mediated mutagenesis; Analysis and isolation of plasmid DNA; Curing of plasmids.

Suggested Readings

Brooker RJ. 2004. Genetics Analysis and Principles. Addison-Wesley Longman.

Brown TA. 2002. Genomes. Bios Scientific Publ.Griffiths AJF. 2000. An Introduction to Genetic Analysis. WH Freeman.

Hexter W & Yost HT. 1976. The Science of Genetics. Prentice Hall.

Karp G. 2004. Cell and Molecular Biology: Concepts and Experiments. John Wiley.

Lewin B. 2008. Genes IX. John Wiley & Sons.

Russell PJ. 1996. Essential Genetics. Blackwell Scientific Publ.

Schleif R.1986. Genetics and Molecular Biology. Addison-Wesley Publ. Co.

Tamarin RH. 1999. Principles of Genetics. Wm C Brown Publ.

Watson JD. 2004. Molecular Bilology of the Gene. Pearson Edu.

Yadav AS, Vasudeva M, Kharab P & Vashishat RK. 2002. Practical Manual on Microbial and Molecular Genetics. Dept. of Genetics, CCS HAU, Hisar.

11020134	ADVANCES IN BREEDING OF MEDICINAL AND AROMATIC CROPS	2+1	Sem-II

Objective

To update knowledge on the recent research trends in the field of breeding of medicinal and aromatic crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

UNIT-I: Origin and evolution of varieties, distribution- Genetic resources, genetic divergence, Plant introduction, selection and domestication - Inheritance of important characters, Genetic mechanisms associated with alkaloids and secondary metabolites.

UNIT-II: Methods of breeding suited to seed and vegetative propagated crops. Polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility. Breeding for resistance to pests, diseases, nematodes in medicinal and aromatic crops.

UNIT-III: Specific breeding objectives in medicinal and aromatic crops, Genetic bio diversity, Breeding problems and improvements in Senna, Periwinkle, Aswagandha, Isabgol, Sarpagandha, Poppy, Glory lily, Coleus, Mucuna and Ocimum, Centella, Bacopa, Dioscorea, Solanum, Andrographis, Aloevera, Phyllanthus, Eucalyptus, Bael, Cinchona.

UNIT-IV: Specific breeding objectives in medicinal and aromatic crops, Genetic bio diversity, Breeding problems and improvements in Henbane aromatic grasses, Geranium, Patchouli, Artemisia, Rosemary, Thyme, Sage, Marjoram, Fever few.

UNIT-V: Biotechnological approaches for crop improvement of medicinal and aromatic crops.

Practical

Description of crops and cultivars, Cataloguing of species and cultivars, floral biology, selfing and crossing, evaluation of hybrid progenies, Induction of economic, colour mutants, Increased alkaloid content in medicinal crops, high essential oil content in aromatic plants, Physical and chemical mutagens, Induction of polyploidy, Screening of plants for biotic and abiotic stresses and environmental pollution, in-vitro breeding in flower crops, medicinal and aromatic crops.

Suggested Readings

Atal C & Kapoor V. 1992. Cultivation and Utilization of Medicinal and Aromatic Crops. CSIR.

Chadha KL & Gupta R. 1995. Advances in Horticulture. Vol.XI. Malhotra Publ. House.

Farooqi AA, Khan MM & Vasundhara M. 2001. Production Technology of Medicinal and Aromatic Crops. Natural Remedies Pvt. Ltd.

Handa SS & Kaul MK. 1982. Cultivation and Utilization of Medicinal Plants. NISC, CSIR.

Jain SK. 2000. Medicinal Plants. National Book Trust.

Julia F & Charters MC. 1997. Major Medicinal Plants – Botany, Cultures and Uses. Thomas Publ.

Prajapati ND, Purohit SS, Sharma AK & Kumar T. 2006. A Hand book of Medicinal Plants. AgroBios.

Thakur RS, Pauri HS & Hussain A. 1989. Major Medicinal Plants of India. CSIR

Minor Subjects:

Seed science technology, agricultural biotechnology, plant pathology, agronomy and entomology are the common subjects taken as minor. The M.Sc. courses of these subjects will complete the requirement of minor courses as decided by the advisory committee of the student and approved by the HOD/ Dean. Some of the courses, which may be taken by a student, are given below:

Course Code	Course Title	Credits	Semester
11020135	Principles of biotechnology	2+1	I
11020136	Fundamentals of molecular biology	3+0	II
11020137	Introduction to bioinformatics	2+0	I
11020138	Plant Tissue culture and genetic transformation	2+1	II
11020139	Molecular Breeding	2+0	II
11020140	Biosafety, IPR and bioethics	2+0	I

11020135	**Principles of biotechnology**	**2+1**	**Sem- I**

Objective

To familiarize the students with the fundamental principles of Biotechnology, various developments in Biotechnology and its potential applications.

Theory

UNIT I: History, scope and importance; DNA structure, function and metabolism.

UNIT II: DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; Gene libraries; PCR amplification; Plant and animal cell and tissue culture techniques and their applications.

UNIT III: Molecular markers and their applications; DNA sequencing; Applications of gene cloning in basic and applied research; Genetic engineering and transgenics; Genomics, transcriptomics and proteomics.

UNIT IV : General application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics; Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

Practical

- Isolation of genomic and plasmid DNA
- Gel electrophoresis techniques
- Restriction enzyme digestion, ligation, transformation and screening of transformants
- PCR and molecular marker analysis
- Plant tissue culture: media preparation, cell and explant culture, regeneration and transformation.

Suggested Readings

Becker JM, Coldwell GA & Zachgo EA. 2007. Biotechnology-a Laboratory Course. Academic Press.

Brown CM, Campbell I & Priest FG. 2005. Introduction to Biotechnology. Panima Pub.

Brown TA. Gene Cloning and DNA Analysis.5th Ed. Blackwell Publishing.

Dale JW & von Schantz M. 2002.From Genes to Genomes: Concepts and Applications of DNA Technology. John Wiley & Sons.

Gupta PK. 2004. Biotechnology and Genomics.Rastogi Publications.

Sambrook J, Fritsch T & Maniatis T. 2001.Molecular Cloning – a Laboratory Manual.2nd Ed. Cold Spring Harbour Laboratory Press.

Singh BD. 2007. Biotechnology Expanding Horiozon. Kalyani Publishers.

11020136	**Fundamentals of molecular biology**	**3+0**	**Sem- II**

Objective

To familiarize the students with the basic cellular processes at molecular level.

Theory

UNIT I: Historical developments of molecular biology; Nucleic acids as genetic material; Chemistry, structure and properties of DNA and RNA.

UNIT II: Genome organization in prokaryotes and eukaryotes; Chromatin structure and function; DNA replication; DNA polymerases, topoisomerases, DNA ligase, etc; Molecular basis of mutations; DNA repair mechanisms.

UNIT III: Transcription process; RNA processing; Reverse transcriptase; RNA editing; Ribosomes structure and function; Organization of ribosomal proteins and RNA genes; Genetic code; Aminoacylt RNA synthases.

UNIT IV: Translation and post-translational modifications; Operon concept; Attenuation of *trp*operon; important features of gene regulation in eukaryotes.

Suggested Readings

Lewin B. 2008. Gene IX. Peterson Publications/ Panima.

Malacinski GM &Freifelder D. 1998.Essentials of Molecular Biology.3rd Ed. Jones & Bartlett Publishers.

Nelson DL & Cox MM. 2007.Lehninger's Principles of Biochemistry. W.H. Freeman & Co.

Primrose SB. 2001. Molecular Biotechnology. Panima.

Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. Molecular Biology of the Gene.6th Ed. Pearson Education International.

11020137	Introduction to bioinformatics	2+0	Sem- I

Objective

To provide hands on training on basic molecular biology techniques.

Practical

UNIT I: Good lab practices; Biochemical techniques: Preparation of buffers and reagents, Principle of centrifugation, Chromatographic techniques (TLC, Gel Filtration Chromatography, Ion exchange Chromatography, Affinity Chromatography).

UNIT II: Gel electrophoresis- agarose and PAGE (nucleic acids and proteins); Growth of bacterial culture and preparation of growth curve; Isolation of plasmid DNA from bacteria; Growth of lambda phage and isolation of phage DNA; Restriction digestion of plasmid and phage DNA; Isolation of high molecular weight DNA and analysis.

UNIT III: Gene cloning – Recombinant DNA construction, transformation and selection of transformants; PCR and optimization of factors affecting PCR.

UNIT IV: Dot blot analysis; Southern hybridization; Northern hybridization; Western blotting and ELISA; Radiation safety and non-radio isotopic procedure.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA &Struhl K. 2002. Short Protocols in Molecular Biology. John Wiley.

Kun LY. 2006. Microbial Biotechnology. World Scientific.

Sambrook J, Russel DW &Maniatis T. 2001. Molecular Cloning: a Laboratory Manual. Cold Spring Harbour Laboratory Press.

11020138	Plant Tissue culture and genetic transformation	2+1	Sem- II

Objective

To familiarize the students about the use of molecular biology tools in plant breeding.

Theory

UNIT I: Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Aspects of molecular breeding.

UNIT II: Development of sequence based molecular markers-SSRs and SNPs; Advanced methods of genotyping; Mapping genes for qualitative and quantitative traits.

UNIT III: QTL mapping using structured populations; AB-QTL analysis; Association mapping of QTL; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene based markers; Allele mining by TILLING and Eco-TILLING; Use of markers in plant breeding.

UNIT IV: Marker assisted selection (MAS) in back cross and heterosis breeding; Transgenic breeding; Foreground and back ground selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples.

Suggested Readings

Chittaranjan K. 2006-07. Genome Mapping and Molecular Breeding in Plants.Vols. I-VII. Springer.

Newbury HJ. 2003. Plant Molecular Breeding. Blackwell Publ.

Weising K, Nybom H,Wolff K & Kahl G. 2005. DNA Finger printing in Plants: Principles, Methods and Applications. Taylor & Francis.

11020139	Molecular Breeding	2+0	Sem- I

Objective

To familiarize the students about the use of molecular biology tools in plant breeding.

Theory

UNIT I: Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Aspects of molecular breeding.

UNIT II: Development of sequence based molecular markers - SSRs and SNPs; Advanced methods of genotyping; Mapping genes for qualitative and quantitative traits.

UNIT III: QTL mapping using structured populations; AB-QTL analysis; Association mapping of QTL; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene based markers; Allele mining by TILLING and Eco-TILLING; Use of markers in plant breeding.

UNIT IV: Marker assisted selection (MAS) in backcross and heterosis breeding; Transgenic breeding; Foreground and background selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples.

Suggested Readings

Chittaranjan K. 2006-07. Genome Mapping and Molecular Breeding in Plants.Vols. I-VII. Springer.

Newbury HJ. 2003. Plant Molecular Breeding. Blackwell Publ.

Weising K, Nybom H, Wolff K &Kahl G. 2005.DNA Fingerprinting in Plants: Principles, Methods and Applications. Taylor & Francis.

11020140	**Biosafety, IPR and bioethics**	**2+0**	**Sem- II**

Objective

To discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products.

Theory

UNIT I: Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.

UNIT II: General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc; Impact on environment: gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of super weeds/ super viruses, etc.

UNIT III: Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-radio isotopic procedure; Benefits of transgenics to human health, society and the environment.

UNIT IV: The WTO and other international agreements; Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products.

Suggested Readings

Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani. http://patentoffice.nic.in, www.wipo.org, www.dbtindia.nic.in, www.dbtbiosafety.nic.in

List of Journals

· Australian Journal of Biological Sciences, Australia
· Biometrics, UK
· Breeding Science, Japan
· Cereal Research Communication, Hungary
· Cotton Research and Development, Hisar, India
· Critical Reviews in Plant Sciences
· Crop Improvement, Ludhiana
· Crop Science, USA
· Current Science, Bangalore
· Czech Journal of Plant Breeding Genetics, Prague,
· Electronic Journal of Biotechnology
· Euphytica, The Netherlands
· FABIS Newsletter
· Genetic resources and crop evolution, Netherlands
· Genetics, USA
· Genome, Canada
· Heredity
· Indian Journal of Agricultural Research, New Delhi
· Indian Journal of Genetics and Plant Breeding, New Delhi
· Indian Journal of Plant Genetic Resources, New Delhi
· International Chickpea Newsletter, ICRISAT
· International Rice Research Notes, IRRI, Philippines
· Journal of Biochemistry and Biotechnology, New Delhi
· Journal of Genetics and Breeding, Italy
· Journal of Heredity
· Journal of Pulses Research, Kanpur
· Legume Research, Karnal
· Molecular Breeding, USA
· Mutation Research
· Nucleic Acids Research, USA
· Rachis, Syria
· Sorghum and Millet Newsletter, ICRISAT
· Theoretical and Applied Genetics, Germany

SGT UNIVERSITY

PROGRAMME OF WORK FOR POST-GRADUATE STUDENTS (Ph.D.)

To be submitted by HOD

To

The Dean
Faculty of Agricultural Sciences,
SGTU, Budhera, Gurugram, NCR-Delhi

The Advisory Committee of----------, son/daughter of Sh. ----------& Smt**.** ----------, Registration No. ---------- admitted in the ---------- in **Ph.D.** programme of **Faculty of Agricultural Sciences** during academic year ---------- Semester -----**,** after consulting him/her in a meeting, makes the following statements and recommendations:

His/Her major field is:

His/Her field of specialization is:

His/Her minor field is:

His/Her academic qualifications prior to joining this programme are:

Degree	**Year of passing**	**Aggregate %age/ OCPA/Division**	**Institution**	**Major Subject**
Sr. Secondary				
B.Sc. (Hons.) Agri.				
M.Sc. Agri.				

Head of Department

Name of Student:---------- **Registration No. ----------**

He/She has studied the following courses in major, supporting and minor fields in Master's programme:

Title of Course	**Course No.**	**Credit Hours**	**Credit point obtained**

Name of Student: ---------- **Registration No.** ----------

He/She shall be required to complete the following Courses:

Classification of Courses	S. No.	Course No.	Title of the course	Credit Hours
(i) Deficiencies to be completed, if any (non credit)	1.			
	2.			
	3.			
	4.			
(ii) Major	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
(iii) Supporting	1.			
	2.			
(iv) Minor	1.			
	2.			
	3.			

Signature of the student

Name of Student: ---------- **Registration No.** ----------

ADVISORY COMMITTEE

S. No.	Name	Designation & Department	Signature
1.	(Major Advisor)		
2.	(Co- Major Advisor)		
3.	(Member Minor Subject)		
4.	(Member Supporting Subject)		
5.	(Nominee of Dean)		

Certified that:

1. The courses shown under deficiency, major, supporting and minor fields are according to the Ordinance
2. The titles and credit hours shown against each course are correct as per Ordinance.
3. The major and minor fields conform to those approved and mentioned in the Ordinance.
4. The Advisory Committee is in accordance with the provisions of the Ordinance.

(Major Advisor) **(Head of the Department)**

Forwarded, in quintuplicate, to the Dean, FASC, SGTU, Budhera, Gurugram, NCR-Delhi.

Head ofthe Department

For office use

Recommended and forwarded to the Dean/Director of Research in quintuplicate.

Dean

Approved

Dean/Director of Research
(With Seal)

CC: Registrar, Dean (FASC), HOD, Major Advisor