Faculty of Agriculture

Bhagwant University, Ajmer (Raj.)

M.Sc. AGRICULTURE COURSE PROGRAMS

INDEX

BHAGWANT UNIVERSITY

Established by Govt. of Raj. & Recognised by UGC

Sikar Road, Ajmer

RAJASTHAN

Syllabus

M.Sc. (Agronomy)

Faculty of Agriculture

Bhagwant University, Ajmer (Raj.)

M.Sc. (Ag.) Course Programs

AGRONOMY

Semester I			
BU Course No	**Course No**	**Course Title**	**Credit Hours**
01MAGR101	**AGRON 511**	Agrometeorology and crop weather forecasting	**3(2+1)**
01MAGR102	**AGRON 512**	Principles and practices of water management	**3(2+1)**
01MAGR103	**AGRON 513**	Principles and practices of soil fertility and nutrient management	**3(2+1)**
01MAGR104	**SOIL 513**	Analytical techniques and instrumental methods in soil and plant analysis	**3(1+2)**
Semester II			
02MAGR101	**AGRON 521**	Modern concepts in crop production	**3(3+0)**
02MAGR102	**AGRON 522**	Principles and practices of weed management	**3(2+1)**
02MAGR103	**AGRON 523**	Dryland farming and watershed management	**3(3+0)**
02MAGR104	**AGRON 524**	Cropping systems and sustainable agriculture	**3(3+0)**
02MAGR105	**STAT 521**	Experimental design	**3(2+1)**
Semester III			
03MAGR101	**AGRON 531**	Agronomy of major cereals and pulses	**3(2+1)**
03MAGR102	**AGRON 532**	Agronomy of oilseeds, commercial and fibre crops	**3(2+1)**
03MAGR103	**PPHYS 531**	Hormonal regulation of plant growth and development	**3(2+1)**
03MAGR104	**SOIL 532**	Management of problem soils and waters	**3(2+1)**
Semester IV			
04MAGR101	**AGRON 541**	M.Sc. Seminar	**1(0+1)**
04MAGR102	**AGRON 542**	Comprehensive	**2(0+2)**
04MAGR103	**AGRON 543**	M.Sc. Research	**15**
		Total	**57**

01MAGR101 Agrometeorology and Crop Weather Forecasting 3(2+1)

Objective

To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

Theory:

Agro meteorology: aim, scope and development in relation to crop environment, composition of atmosphere, distribution of atmospheric pressure, Solar radiation : characteristics, energy balance of atmosphere system, radiation distribution in plant canopies, radiation utilization by field crops, photosynthesis and efficiency of radiation utilization by crops, energy budget of plant canopies, Environmental temperature: soil, air, canopy temperature, temperature profile in air, soil and crop canopies, soil and air temperature effects on plant processes, regulation of air, soil temperature for protection against frost and hot winds, Environmental moisture and evaporation, measures of atmospheric moisture, temperature, relative humidity, vapour pressure and their relationship, evapotranspiration and meteorological factors determining evapotranspiration, Modification of plant environment: artificial rain making, controlling heat load, heat trapping and shedding, protection from cold, reduction in sensible and latent heat flux, Monsoon: monsoon and their origin, characteristics of monsoon, onset and progress of monsoon, withdrawal of monsoon, Weather forecasting in India: short, medium and long range forecasting, benefits of weather service to agriculture, forecasting of destructive frost, soil moisture forecast, phenological forecast, crop yield forecast, Aero-space science and remote sensing : application in agriculture, present status of remote sensing in India, Atmospheric pollution and its effect on climate and crop production.

Practical

Agrometeorological observatory- classes, site selection, layout and installation of meteorological instruments; handling of meteorological instruments; measurement of weather parameters; working out agroclimatic indices; maintenances of record; calculation of daily, weekly and monthly means; visit to state remote sensing centre, Jodhpur/Jaipur; measurement of soil temperature in different soil conditions/depths; interpretation and use of weather data; rainfall analysis for variability; moisture availability indices for an arid and a humid district, length of growing season, fitting cropping systems; preparation of weather maps, synoptic charts and weather reports; preparation of crop weather calendars, to become familiar with agro advisory service bulletins visit to ARS, Durgapura/Bikaner.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Agro meteorology - aim, scope and development in relation to crop environment	2
2	Composition of atmosphere, distribution of atm. pressure	1
3	Solar radiation – characteristics	1
4	Energy balance of atmosphere system	1
5	Radiation distribution in plant canopies, radiation utilization by field crops	2
6	Photosynthesis and efficiency of radiation utilization by crops	2
7	Energy budget of plant canopies	1
8	Environmental temperature- soil, air, canopy temperature, temperature profile in air, soil, crop canopies	2
9	soil and air temperature effects on plant processes	2
10	Regulation of air, soil temperature for protection against frost and hot winds	2
11	Environmental moisture and evaporation - measures of atmospheric moisture,	2
	temperature, relative humidity, vapour pressure and their relationship	
12	Evapotranspiration and meteorological factors determining evapotranspiration	2
13	Modification of plant environment, artificial rain making, controlling heat load, heat	2
	trapping and shedding	
14	Protection from cold, reduction in sensible and latent heat flux	1
15	Monsoon and their origin, characteristics of monsoon	1
16	Onset and progress of monsoon withdrawal of monsoon	1
17	Weather forecasting in India: short, medium and long range forecasting	2
18	Benefits of weather service to agriculture, forecasting of destructive frost, soil moisture	2
	forecast, phonological forecast, crop yield forecast etc.	
19	Aero-space science and remote sensing - application in agriculture, present status of remote sensing in India.	2
20	Atmospheric pollution and its effect on climate and crop production	1

Lecture schedule- Practical

S. No.	Topic	No. of lectures
1	Agro meteorological observatory – classes, site selection, layout and installation procedures for meteorological instruments	1
2	Handling of meteorological instruments	1
3	Measurement of weather parameters	1
4	Working out agro climatic indices	1
5	Maintenance of records	1
6	Calculation of daily, weekly and monthly means	2
7	Visit to state Remote Sensing Centre, Jodhpur/Jaipur	1
8	Measurement of soil temperature in different soil conditions/depths	1
9	Interpretation and use of weather data	1
10	Rainfall analysis for variability	2
11	Moisture availability indices for an arid district	1
12	Moisture availability indices for a humid district	1
13	Length for growing season, fitting cropping systems	1
14	Preparation of weather maps, synoptic charts & weather reports	1
15	Preparation of crop weather calendar	1
16	To become familiar with Agro-advisory-service bulletins/	1

Suggested Readings:

S. Mavi (1994). Introduction to Agrometeorology. Oxford & IBH Publishing Co. New Delhi.

P.A. Menon (1989). Our weather. National Book Trust, New Delhi.

A.A. Rama Sastu (1984). Weather and Weather forecasting Publication Division,

GOI. P.K. Das (1992). The Monsoon. National Book Trust, New Delhi.

S. Venkateraman and A. Krishnan. Crops and Weather. Indian Council of Agricultural Research, New Delhi. Critchfield, H.J. 1995. General Climatology, Prentice Hall of India Pvt. Ltd., New Delhi

R.S. Gena and S.P. Seetharaman (1991). Natural Resource Management: The Role of Remote sensing in decision making. Oxford & IBH Publishing Co. New Delhi.

K.L. Joshi, Sinha and D.P. Gupta (1985). Physical Geography, National Council of Educational Research and Training, New Delhi.

VasirajuRadha Krishna Murthy (1995). Practical Manual on Agricultural Meteorology, Kalyani Publishers, Ludhiana.

D.S. Lal, 1998. Climatology. ShardaPustakBhawan.

S.R. Ghadekar, 1991. Meteorology, Agromet Publishers, Nagpur.

A.K. Sacheti, 1985. Agricultural Meteorology- Instructional-cum-Practical Manual. NCERT, New Delhi.

Mavi H.S. and Tuper G.J. 2004. Agrometeorology: Principles and Application of Climate Studies in Agriculture. Haworth Press.

Vashneya M.C. and Balakrishana Pillai P. 2003. Textbook of Agricultural Meteorology, ICAR.

01MAGR102 Principles and Practices of Water Management 3(2+1)

Objective

To teach the principles of water management and practices to enhance the water productivity.

Theory:

Water, its properties and role in plants; Water resources of India, Major irrigation projects and extent of area and crops irrigated in India; Water potential – concept, components and relationship between different components; Water movement in plant and soils; Absorption and transpiration of water in plants; Scheduling and methods of irrigation including micro irrigation system; Fertigation, Water use efficiency: Water management of crops and cropping systems; Soil, plant and meteorological factors deter mining water needs of crops; Water deficit stress in plants and its effect on growth. Quality of irrigation water – effect of saline water and soil salinity on plants and its management, Excess soil water and plant growth; Water management in problem soils; Drainage requirement of crops and methods of drainage, their layout and spacing.

Practical:

Determination of soluble salts, Ca + Mg, $CO_3^{=}$ and HCO_3^{-} and Na in irrigation water; Determination of FC and PWP; Soil moisture measurement by tensiometer and pressure plate apparatus; Water flow measurement using different devices. Determining soil profile moisture deficit and irrigation requirement. Calculations on irrigation efficiencies; Computation of water requirement of crops using modified Penman formula. Determination of infiltration rates and hydraulic conductivity.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Water, its properties and role in plants	2
2	Water resources of India, major irrigation projects, and extent of area and crops irrigated in India	3
3	Water potential-concept, components and relationship between different components	2
4	Water movement in plants and soils	2
5	Absorption-types and relative importance	2
6	Transpiration – types and methods to reduce transpiration	2
7	Scheduling of irrigation and methods of irrigation including micro irrigation system, Fertigation	2
8	Water use efficiency and factors affecting it	2
9	Water management of crops and cropping systems	2
10	Soil, plant and meteorological factors determining water needs of crops	2
11	Water deficit stress in plants and its effect on growth	2
12	Quality of irrigation water-criteria used, effect of poor quality water on plant growth and management of saline water for irrigation	3
13	Excess soil water and plant growth	2
14	Water management in problem soils	2
15	Drainage requirement of crops and methods of drainage, their layout and spacing	2

Lecture schedule- Practical

S. No.	Topic	No. of lectures
1	Determination of soluble salts and Ca + Mg in irrigation water	1
2	Determination of $CO_3^{=}$ and HCO_3^{-} and Na in irrigation water	1
3	Determination of FC and PWP	2
4	Determination of soil moisture by tensiometer and pressure plate apparatus	2
5	Water flow measurement using different devices	2
6	Determining soil profile moisture deficit	1
7	Determination of irrigation requirement of crops	2
8	Calculations on irrigation efficiencies	2
9	Computation of water requirement of crops using modified Penman formula	1
10	Determination of infiltration rate of soil	1
11	Determination of hydraulic conductivity of soil	1

Suggested Readings:

A.M. Michael, 1987. Irrigation – Theory and Practice, Vikas Publishing House Pvt. Ltd., New Delhi

S.S. Parihar and B.S. Sandhu, 1978. Irrigation of field crops – Principles and Practices, ICAR, New Delhi

D. Lenka, 1999. Irrigation and Drainage. Kalyani Publishers, New Delhi.

R.D. Mishra and M. Ahmed. 1987. Manual on Irrigation Agronomy, Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi

G.H. Sankara Reddy and T. Yellamanda Reddy. 1995. Efficient use of irrigation water. Kalyani Publishers, New Delhi

K.V. Paliwal. 1972 Irrigation with saline water WTC, IARI, New Delhi.

I.C. Gupta 1990. Use of saline water in Agriculture. Oxford & IBH Pub. Co. Ltd., New Delhi

P.J. Kramer and J.S. Boyer 1995. Water relations of Plants & Soils, Academic Press, California, USA.

S.R. Reddy 2000. Principles of Crop Production, Kalyani Publication, New Delhi.

D.K. Majumar 2004. Irrigation water management – principles and practice, Prentice Hall of India, New Delhi.

S.C.Panda 2003. Principles and practices of water management. Agrobios, Jodhpur

Singh Pratap and Maliwal P.L. 2005. Technologies for Food Security and Sustainable Agriculture. AgrotechPublc.

01MAGR103 Principles and Practices of Soil Fertility and Nutrient Management 3(2+1)

Objective

To impart knowledge of soil fertility and plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil resources.

Theory:

Problems and management relating to mechanical impedence and soil submergence; Salt affected soils - problems and remedial measures; Soil acidity and remedial measures; Soil fertility and productivity concept and differences: Criteria of essentiality and forms in which nutrients are absorbed by plants; Physiological methods of increasing FUE. **Nitrogen:** Functions, deficiency and toxicity symptoms, forms of nitrogen, nitrogen transformation in soil, organic and mineral N balance in soil, mineralization of N compounds, losses of N from soil, nitrogenous fertilizer materials. Methods to increase N use efficiency and slow release fertilizers; Biological N fixation, symbiotic and free living N fixers; **Phosphorus:** Functions and deficiency symptoms, forms of P in soil, their availability and P fixation, various phosphatic fertilizers; Practices of increasing the effectiveness of applied and native phosphorus (PSB). **Potassium:** Functions and deficiency symptoms, forms of K in soil, fixation and release of potassium in soil; Potassic fertilizers and their application. Sulphur and micronutrients (Fe, Zn) functions, deficiency symptoms and application; Inter relationship of nutrient availability and soil pH; Important nutrient interactions and their effect on nutrient availability, cation exchange capacity and availability of plant nutrients; Integrated nutrient management.

Practical:

Procedure of plant and soil sampling; Determination of soil pH, EC and organic carbon; Determination of total N and available N, P and K in soils; Determination of N, P, K and S in plant samples; Determination of Ca, Mg and Na in soil; Determination of gypsum requirement of alkali soils.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Soil problems relating to mechanical impedence and their management / remedial Measures	1
2	Soil submergence - meaning, causes and electro chemical changes occurring (oxidized-reduced zones and redox potential)	2
3	Salt affected soils – characteristics, classification and their remedial measures	2
4	Soil acidity-characteristics, reasons of soils acidity and remedial measures/ amelioration	2
5	Soil fertility and productivity concept and differences	1
6	Criteria of essentiality and forms in which nutrients are absorbed by plant.	2
7	Physiological methods of increasing FUE	1
8	**Nitrogen**:	
	Functions, deficiency and toxicity symptoms, forms of nitrogen, N – transformation in soil, organic and mineral nitrogen balance in soil, mineralization of N compounds and factors affecting nitrification, losses of N from soil.	4
	N-fertilizers, slow release fertilizers and methods to increase nitrogen use efficiency	1
	Biological nitrogen fixation, symbiotic and free living N fixers	2
9	**Phosphors**	
	Functions and deficiency symptoms, forms of P in soil and their availability, P availability in relation to pH, P-fixation.	2
	Various P fertilizers and practices of increasing the effectiveness of applied and native phosphorus (PSB)	2
10	Potassium:	
	Functions and deficiency symptoms, forms of K in soil fixation and release of K in soils, factors affecting K availability	3
	Potassic fertilizer and their application	1
11	Sulphur and micronutrients (Fe & Zn) – functions, deficiency symptoms and application	2
12	Interrelationship of nutrient availability and soil pH	1
13	Important nutrient interactions and their effect on nutrient availability, cation exchange capacity and availability of plant nutrients	2
14	Integrated nutrient management concepts	1

Lecture schedule- Practical

S. No.	Topic	No. Of lectures
1	Procedure of plant and soil sampling	1
2	Determination of soil pH, ECe and organic carbon	3
3	Determination of total N and available N, P and K in soil	4
4	Determination of total N, P, K and S in plant samples	4
5	Determination of Ca, Mg and Na in soil	2
6	Determination of gypsum requirement of alkali soils	2

Suggested Readings:

1. S.L. Tisdale, W.L. Nelson, J.D. Beaton and J.L. Havlin. 1997. Soil Fertility and Fertilizers. Prentice Hall of India, Pvt. Ltd., New Delhi
2. T.R. Reddy a G.H.S. Reddi 1992. Principles of Agronomy, Kalyani Publishers, New Delhi
3. L.A. Richards, 1968. Diagnosis and Improvement of Saline and Alkali Soils, Oxford and IBH Publishing Company, New Delhi
4. Tamhaney, Motiramani, Bali and Donahu, 1970. Soils Their Chemistry and Fertility in Tropical Asia, Prentice Hall of India, New Delhi
5. R.R. Agarwal, J.S. P. Yadav and S.N. Gupta, 1982. Saline and Alkalai soils of India. ICAR Publication, New Delhi
6. G.Singh, J.S. Kolar and H.S. Sekhon, 2002. Recent Advances in Agronomy, Indian Society of Agornomy, IARI, New Delhi
7. J.S. Kanwar, 1978. Soil Fertility: Theory and Practices, ICAR Publication, New Delhi
8. J.L. Havlin, J.D. Beaton, S.L. Tisdale and WL. Nelson, 2006. Soil Fertility and Fertilizers- An Introduction to Nutrient Management, Prentice Hall of India, Pvt. Ltd., New Delhi
9. N.C. Brady and R.R. Weil, 2003. Elements of the Nature and Properties of Soils. Prentice Hall, New Jersey.
10. R.S. Yawalkar, J.P. Agarwal and J. Bokde 1992. Manures and Fertilizers. Agri-Horticultural House, Nagpur
11. N.K. Fageria, V.C. Baligar and C.A. Jones 1991. Growth and Mineral Nutrition of Field Crops. Marcel Dekker, New York.

01MAGR104 Analytical techniques and instrumental methods in soil and plant analysis 3(1+2)

Objective

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Theory

Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods.

Practical

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity,analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods, drawing normalized exchange isotherms; measurement of redox potential.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Principles of visible, ultraviolet and infrared spectrophotometery	2
2.	Princuple and instrumentation of atomic absorption spectrophotometer	2
3.	Principles of flame-photometry	1
4.	Principles and instrumentation of inductively coupled plasma spectrometry	2
5.	Principles and instrumentation of chromatographic techniques	4
6.	Principles of mass spectrometry and X-ray defractrometery	2
7.	Principles of identification of minerals by X-ray by different methods.	3

Lecture schedule—Practical

S. No.	Topic	No. of lecture
1.	Analytical chemistry – Basic concepts, techniques and calculations	3
2.	Principle of analytical instruments and their calibration for soil and plant analysis	2
3.	Determination of available nitrogen in soil	1
4.	Determination of available phosphorus in soil	1
5.	Determination of available potassium in soil	1
6.	Determination of available sulphur in soil	1
7.	Determination of available Boron in soil	1
8.	Determination of available molybdenum in soil	1
9.	Determination of iron, cupper, manganese and zinc in soil	1
10.	Determination of potential buffering capacity of phosphorus	1
11.	Determination of potential buffering capacity of potassium	1
12.	Determination of ammonium fixation capacity of soil	1
13.	Determination of potassium fixation capacity of soil	1
14.	Determination the cation exchange capacity of soil	1
15.	Determination the anion exchange capacity of soil	1
16.	Determination of calcium and magnesium in soil	1
17.	Determination of Sodium in soil	1
18.	Estimation of root cation exchange capacity	1
19.	Determination of nitrogen in plant	1
20.	Determination of phosphorus in plant	1
21.	Determination of potassium in plant	1
22.	Determination of sulphur in plant	1
23.	Determination of calcium and magnesium in plant	1
24.	Determination of boron in plant	1

25.	Determination of molybdenum in plant	1
26.	Determination of iron, cupper, manganese and zinc in plant	1
27.	Estimation of root cation exchange capacity	1
28.	Drawing normalized exchange isotherms; measurement of redox potential	2

Suggested Readings

Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes& Sons.
Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.
Kenneth Helrich 1990. *Official Methods of Analysis* Association of Official Analytical Chemists.
Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
Piper CE. *Soil and Plant Analysis*. Hans Publ.
Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis–A Methods Manual*. IARI, New Delhi.
Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.
Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.
Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

02MAGR101 Modern Concepts in Crop Production 3(3+0)

Objective

To teach the basic concepts of soil management and crop production.

Theory:

Agronomic aspects in food security; Crop growth and production in relation to climate change; Agro ecological and agroclimatic zones of India; Concept of potential yield; Modern concepts in tillage - zero, minimum and conservation tillage; Optimization of plant population and planting geometry in relation to soil fertility, solar radiation and available moisture regimes; Mitscherlich , Baule and Inverse yield : nitrogen laws; Biotic and abiotic stresses; Concept of ideal plant type; Organic farming, Physiology of grain yield in cereals; Crop growth analysis; Crop modelling in agronomic systems; Precision agriculture; Growth regulators and their role in agriculture; Designer crops; Vermi-technology; Agro biodiversity; Seed priming; ; Indigenous technological knowledge; Herbicide resistance in weeds; Allelopathy in agriculture ; Plant nutrition and disease tolerance in field crops.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Population and food requirement	1
2	Agronomic techniques for food security, crop nutrition, value addition	2
3	Effect of climate change on crop production	1
4	Direct and interactive effect of different climatic parameters on crop production	2
5	Agroecological and agroclimatic zones of India and their introduction	2
6	Concept of potential yield	1
7	Introduction to modern concepts of tillage - zero tillage minimum tillage, furrow irrigated raised bed system, resource conservation	3
8	Conservation tillage - its advantages, disadvantages , types and Methods	1
9	Relationship between plant population and yield and response curves	1
10	Optimum plant population in relation to soil fertility and solar radiation	1
11	Mitscherlich equation, Baule unit and inverse yield: nitrogen laws	2
12	Abiotic and biotic stresses	2
13	Definition and concept of ideal plant type	1
14	Characteristics of an Ideotype plant for dryland agriculture	1
15	Ideotype plant for wheat	1
16	Organic farming – definition, differences between conventional and organic farming and principles and components of organic farming	2
17	Physiology of grain yield in cereals	2
18	Growth curves and analysis of crop growth : LAI, CGR, RGR, NAR, LAD	2
19	Crop model-definition, concept and types (empirical & mechanistic)	1
20	Scientific basis of modelling	1
21.	Model applications	1
22	Precision agriculture-definition, basic concept, scope and approach	1
23.	Technologies for precision agriculture: computers, geographical information system (GIS), global positioning, system (GPS), sensors, etc.	2
24.	Plant growth regulators-definition, types and their role in crop Production	2
25	Designer crops - concept and importance	2
26	Vermi- technology , meaning, methods and scope	2
27	Agro- biodiversity- definition, effects, threats and conservation	2
28	Seed priming- concept, importance and use in crop production	1
29	Indigenous technological knowledge and its use in crop production	1
30	Herbicide resistance in weeds – meaning and management of resistant weeds	2
31	Allelopathy in agriculture	1
32	Plant nutrition and disease tolerance in field crops	1

Suggested Readings:

1. Gardner, F.P.;Pearce, G.R. and Michell, R.I. Physiology of Crop Plants, Scientific Pub., Jodhpur.
2. S.P. Palaniappan and Shivarama,K. 1996. Cropping Systems in the Tropics - Principles and Management. New Age International Pub.
3. Fageria, N.K. 1992. Maximising crop yields. Marcel Dekker, New York.
4. Reddy,S.R. 2000. Principles of Agronomy. Kalyani Pub. New Delhi.
5. Sankaran, S. and Mudaliar ,T.V.S. l997. Principles of' Agronomy. The Bangalore Printing and Pub. Bangalore.
6. Redford, J. 1967. Growth Analysis formulae: Their use and abuse. Crop Science. 76:171 - 175.
7. Singh, G.; Kolar, J.S. and Sekhon, H.S. 2002 Recent Advances in Agronomy (Ed). ISA, Publication, New-Delhi.
8. Paroda, R.S. 2003. Sustaining Our Food Security. Konark Publishers Pvt. Ltd., Delhi
9. Balasubrammaniyan P. and Palaniappan, S.P. 2001. Principles and Practices of Agronomy. Agrobios
10. Havlin J.L., Beaton J.D., Tisdale S.L. and Nelson W.L. 2006. Soil Fertility and Fertilizers. 7^{th} Ed. Prentice Hall.

02MAGR102 Principles and Practices of Weed Management 3(2+1)

Objective

To familiarize the students about the weeds, herbicides and methods of weed control.

Theory

Weed–biology, ecology and classification; history, development and classification of herbicides, their properties, mode of action and uses, basis of selectivity of herbicides; herbicide mixtures, adjuvants and safeners; weed control principles and management practices in important grain crops, oilseeds, pulses, sugar, fibre crops, tuber crops and forage crops; vegetables and orchards; weed control under specific situations viz. intercropping systems, non cropped areas and drylands; noxious farm weeds and parasitic weeds and their control; fate of herbicides in soil; herbicide - pesticides and fertilizer interactions; allelopathic effect; integrated weed management; problem of aquatic weeds particularly water hyacinth, hydrilla and typha grass in Rajasthan and their possible control measures; weed control through bio herbicides and myco- herbicides; herbicide resistance in weeds and crops.

Practical:

Identification of common k*harif*, *rabi* and perennial weeds of crop fields, road sides, waste lands and irrigation channels; familiarization with trade names, common names, uses, cost and source of availability of herbicides; calibration of sprayer and maintenance (before and after use); study of different herbicidal formulations; calculation on herbicidal requirement for field crops and aquatic situation; application of herbicides in field crops; control of some noxious weeds by cultural and chemical means; study on weed control efficiency and calculation on weed infestation and weed index; preparation of weed herbarium, methodology for weed control research and precautions in handling or storage of herbicides.

Lecture schedule – Theory

S. No.	Topic	No. of lectures
1	Weeds- biology, ecology and classification	2
2	Herbicides -	2
	a) History, development and classification of herbicides	2
	b) Properties of herbicides	2
	c) Mode of action and uses of herbicides	2
	d) Basis of selectivity of herbicides	2
3	Herbicide mixtures, adjuvants and safeners	2
4	Weed control principles and management practices in important crops	1
	a) Grain crops	2
	b) Oilseeds and pulses	2
	c) Sugar and fibre crops	1
	d) Tuber and forage crops	2
	e) Vegetable crops	2
	f) Orchards	1
5	Weed control under specific situations – intercropping system, drylands and non cropped area	1
6	Noxious farm weeds, parasitic weeds and their control	1
7	Fate of herbicides in soil	2
8	Herbicide- pesticides and fertiliser interactions	1
9	Allelopathic effects	1
10	Integrated weed management	1
11	Problem of aquatic weeds particularly water hyacinth, hydrilla and typha grass in Rajasthan and their possible control measures	1
12	Weed control through bio-herbicides and myco- herbicides	1
13	Herbicide resistance in weeds and crops	1

Lecture schedule-Practical

S. No.	Topic	No. Of Lectures
1	Identification of common *Kharif* and *Rabi* weeds	1
2	Identification of perennial weeds of crop fields, road sides, wastelands and irrigation Channels	1
3	Familiarization with trade names, common names, uses, cost and sources of availability of Herbicides	1
4	Calibration of sprayers and maintenance (before and after use)	1
5	Study of different herbicidal formulations	1
6	Calculation on herbicidal requirement for field crops under aquatic situations	2
7	Application of herbicides in field crops	2
8	Control of some noxious weeds by cultural and chemical means	1
9	Study on weed control efficiency and calculation on weed infestation and weed index	2
10	Preparation of weed herbarium	2
11	Methodology for weed control research	1
12	Precautions in handling or storage of herbicides	1

Suggested Readings :

Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.
Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides.* 2nd Ed. Wiley Inter-Science.
Gupta OP. 2007. *Weed Management–Principles and Practices.*Agrobios.
Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices.* Agro-Botanical Publ.
Rao VS. 2000. *Principles of Weed Science.* Oxford & IBH.
Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani.
Zimdahl RL. 1999. *Fundamentals of Weed Science.* 2nd Ed. Academic. Press

02MAGR103Dryland Farming and Watershed Management 3(3+0)

Objective

To teach the basic concepts and practices of dryland farming, soil moisture conservation and watershed management.

Theory:

Definition, concept, significance and dimensions of dryland farming in Indian agriculture, characteristics of dryland farming and dryland versus rainfed farming: constraints limiting crop production in dry land areas; characterisation of environment for water availability; delineation of dry farming areas on the basis of moisture deficit index and their characteristics, use of mulches, kinds, effectiveness and economics; antitranspirants- their types, mechanism and role in dry farming; water harvesting- its concepts, techniques and practices; soil and crop management techniques- tillage, seeding, fertilizer use, crop and varietal choice, cropping system, weed control and other management practices; plant ideotypes for drylands, drought management strategies; preparation of appropriate crop plans for dryland areas; midseason corrections for aberrant weather conditions. Watershed management- definition, objectives, concepts, problems, approach components, development of cropping systems for watershed areas; alternate land use systems; planning and operation of project for watershed management.

Lecture Schedule- Theory

S. No.	Topic	No. of Lectures
1	Dryland farming- definition, concept, significance and dimensions of dryland farming in India agriculture	3
2	Characteristics of dryland farming and dryland versus rainfed farming	3
3	Constraints limiting crop production in dry land areas	3
4	Characterisation of environment for water availability	3
5	Delineation of dry farming areas on the basis of moisture deficit index and their characteristics,	3
6	Use of mulches, kinds, effectiveness and economics	3
7	Antitranspirants- their types, mechanism and role in dry farming	3
8	Water harvesting, its concepts, techniques and practices	3
9	Soil and crop management techniques- tillage, seeding, fertilizer use, crop and varietal choice, cropping system, weed control and other management practices	5
10	Plant ideotypes for drylands	2
11	Drought management strategies	3
12	Preparation of appropriate crop plans for dryland areas	2
13	Mid season corrections for aberrant weather condition	2
14	Watershed management- Definition, objectives, problems, approach and components	3
15	Development of cropping system for watershed areas	3
16	Alternate land use systems	3
17	Planning and operation of project for watershed management	3

Suggested Readings:

R.P. Singh, Sriniwas Sharma, M.V. Padmanabhan, S.K. Das and P.K. Mishra, 1990. A Field Manual on Watershed Management, ICAR (CRIDA) Publication, Hyderabad.

S.C. Verma and M.P. Singh. 1984. Agronomy of New Plant Types. Tara Book Agency, Varanasi.

S. Palaniappan. 1985. Cropping Systems in Tropics: Principles and Management, Wiley Eastern Ltd., New Delhi & TNAU, Coimbatore.

Mahendra Pal, K.A. Singh and I.P.S. Ahlawat. 1985. Cropping System Research I & II. In processing of the National Symposium on Cropping Systems Published by ISA, New Delhi.

Efficient Crop Management in Dry Farming Areas. 1985. ICAR (CRIDA) Publication, Hyderabad.

R.D. Asana, 1968. Growth Habit & Crops of Non-Irrigated Areas, Important Characters of Plant Types, Ind. Farming, 81:25-27.

U.S. Gupta, 1975. Physiological Aspect of Dryland Farming, Oxford & IBH, New Delhi.

T.Y. Reddy and C.H. ShankaraReddi. 1992. Principles of Agronomy, Kalyani Publishers, New Delhi.

V.V. Dhurva Narayan, R.P. Singh, S.P. Bhardwaj, M., Sharma, A.K. Sikka, K.P.R. Vittal and S.K. Das. 1987. Watershed Management for Drought Mitigation, ICAR Publication, New Delhi.

U.S. Gupta. 1995. Production and Improvements of Crops for drylands, Oxford & IBH Publishing Co. Ltd, New Delhi

J.C. Katyal and J. Farrigtion, 1995. Research for Rainfed Farming, CRIDA, Hyderabad.

P. Ramaswamy, 1982. Dry farming technology in India. Agricole Publishing Academy, New Delhi.

S.D. Singh, Water harvesting in Desert, Manak Publication, New Delhi.

R.P. Singh 1995. Sustainable Development of Dryland Agriculture in India, Scientific Publishers, Jodhpur. N.R. Das, 2007. Tillage and crop production. Scientific Publishers, Jodhpur

02MAGR104 Cropping Systems and Sustainable Agriculture 3(3+0)

Objective

To acquaint the students about prevailing cropping systems and sustainable agriculture in the country and practices to improve productivity.

Theory:

Cropping systems- intercropping and multiple cropping, concepts, needs, indices and assessment; existing cropping systems under irrigated and rainfed situations. Cropping system indices viz., relative spread index and relative yield index. Farming system: integrated farming system, alternate farming system - meaning and scope including specific examples. Recycling and crop residue management. Natural farming - concept and components. Organic farming. Crop diversification – principles, types and needs, Sustainable agriculture - definition, scope and objectives, Natural resources, their characterization and management; Sustainable cropping and farming systems in agriculture in relation to environmental degradation; Research needs on sustainable agriculture.

Lecture schedule – Theory

S. No.	Topic	No. of lectures
1	Cropping systems – definition and types	2
2	Intercropping – concept, needs, types, indices and assessments	3
3	Multiple cropping - concept and needs, Types, selection of crops and computation of Indices	6
4	Cropping systems under irrigated conditions	5
5	Cropping systems for rainfed situation	2
6	Cropping system indices - relative spread index and relative yield index	2
7	Farming systems - integrated farming systems; definition, its components and IFS Models	3
8	Alternate farming systems – meaning, scope and specific examples	3
9	Recycling and crop residue management	2
10	Natural farming – concept and components	2
11	Organic farming - definition, concept and components	2
12	Relevance of organic farming in present context its certification and accreditation	3
13	Crop diversification – principles, types and needs	3
14	Sustainable agriculture – definition, scope and objectives	2
15	Natural resources – their characterization and management	3
16	Sustainable cropping and farming systems in relation to environmental degradation	3
17	Research needs on sustainable agriculture	2

Suggested Readings:

K.N. Singh and R.P. Singh (Eds), 1990. Agronomic Research Towards Sustainable Agriculture, Indian Society of Agronomy, New Delhi

R.P. Singh, 1990. Sustainable Agriculture: Issues ,Perspectives and Prospects in Semi Arid Tropics. Vol I & II Indian Society of Agronomy, New Delhi

Proceedings of the National Symposium on Cropping Systems 1985. Indian Society of Agronomy, New Delhi

R.M. Devlin and E.H. Watham. 1986. Plant Physiology. CBS Publishers and Distributors, New Delhi.

L.L.Somani, K.L. Totawat and B.L. Baser. 1992 (Ed.) Proceedings of National Seminar on Natural Farmin g, NSMP Publication, Rajasthan College of Agriculture, Udaipur

K. Balakrishnan Nair, U.N. Goswami and K. Kunhkrishnan 1972 (Ed.) Proceedings of the Symposium on Cropping Patterns in India. ICAR Publication, New Delhi.

R.W. Willey 1979. Intercropping: Its Importance and Research Needs, Field Crop Abstracts 332:1-10 & 73-81

S.C. Panda. 2004. Cropping Systems and Farming Systems. Agrobios (India) Jodhpur

Guriqbal Singh, J.S. Kolar and H.S. Sekhon 2002. Recent Advances in Agronomy, Indian Society of Agronomy, IARI, New Delhi

Singh, S.S. 2006. *Principles and Practices of Agronomy.* Kalyani Publishers, Ludhiana.

02MAGR105 Experimental Designs 3(2+1)

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. 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

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control, Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design, Factorial experiments, (symmetrical as well as asymmetrical), orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment, 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, resolvable designs and their applications ~ concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures. **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; Analysis of resolvable designs; Fitting of response surfaces.

Lecture schedule: Theory

S. No.	Topics	No. of Lectures
1.	Basic concepts of design of experiment	2
2.	Basic principles of designs	3
3.	Uniformity trials	1
4.	Size and shape of plots and blocks	1
5.	Analysis of variance and transformations	2
6.	CRD, RBD and LSD	3
7.	Factorial experiments	4
8.	Confounding in symmetrical factorial experiments	2
9.	Factorial experiments with control treatment	2
10.	Split plot design	2
11.	Strip plot design	2
12.	Analysis of covariance and missing plot techniques	2
13.	crossover designs	1
14.	resolvable designs	1
15.	Response surfaces	2
16.	Experiments with mixtures	2

Lecture schedule: Practical

S. N.	Topics	No. of Lectures
1.	Formation of plots	1
2.	Formation of blocks	1
3.	Analysis of CRD	1
4.	Analysis of RBD	1
5.	Analysis of LSD	1
6.	Analysis of factorial experiment	1
7.	Analysis of asymmetric factorial experiments	1
8.	Analysis of confounded factorial experiments	1
9.	Analysis with missing data in RBD	1
10.	Analysis with missing data in LSD	1
11.	Transformation of data	1
12.	Analysis of SPD	1
13.	Analysis of strip plot design	1
14.	Analysis of resolvable designs	1
15.	Fitting of response surfaces	2

References:

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

03MAGR101 Agronomy of Major Cereals and Pulses 3(2+1)

Objective

To teach the crop husbandry of major cereals and pulses.

Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of rice, wheat, maize, barley, sorghum, pearl millet, chickpea and pigeon pea.

Practical

Phenological studies at different growth stages of crops, different methods of raising nursery including dapog in rice; estimation of crop yields on the basis of yield attributes; calculation of fertilizer requirements and their application at different stages of growth on the basis of soil test values; computation of cost of cultivation of various crops, planning and layout of field experiments, formulation of cropping scheme for various farm sizes, calculation of cropping and rotation intensities, visit of field experiments for cultural, fertilizer, weed control and water management aspects; working out indices of intercropping systems – L.E.R. aggressivity, relative crowding coefficient and monetary yield advantage, ATER; determination of physiological maturity in different crops; working out of harvest index in various crops; computation of growth analysis indices. Study of root nodules and seed treatment with bio-fertilizers in pulses, Estimation of protein in pulses.

Lecture schedule – Theory

S. No.	Topic	No. of lectures
1	**Rice:** Importance, production, distribution and classification, Cropping systems, agronomy of hybrid rice and climate, Climate, soil and cultural requirements and improved varieties, Nutrient, water and weed management in relation to latest research, Crop protection, handling and processing of produce, quality components and industrial uses of main and by products.	5
2	**Wheat:** Importance, production, distribution and classification, Cropping systems, adaptability in different agro climatic zones, climate and improved varieties, Soil and cultural requirements ,Nutrient, water and weed management in relation to latest research, Crop protection, handling and processing of produce.	5
3	**Maize:** Importance, production, distribution, cropping systems and classification, Adaptability in different agro climatic zones, climate, soil and cultural requirements and improved varieties, Nutrient, water and weed management in relation to latest research, Crop protection, handling and processing of produce, Prospects of *rabi* maize cultivation in India and its package	5
4	**Barley:** Importance, production, distribution, classification and cropping systems, Adaptability in different agro-climatic zones, climate, improved varieties, soil and cultural requirements Nutrient, water and weed management, Crop protection, handling and processing of produce, quality components and industrial uses of the main and by products.	3
5	**Sorghum** : Importance, production, distribution and cropping systems, Adaptability in different agro-climatic zones, climate, improved varieties, soil and cultural requirements, nutrient, weed and water management in relation to latest research, Crop protection, handling and processing of produce, quality components and industrial uses of the main and by products	4
6	**Pearl millet** : Importance, production, distribution and adaptability in different agroclimatic zones, Cropping systems, climate, improved varieties, soil and cultural requirements for maximization of production, Nutrient, weed and water management in relation to latest research, Plant protection, handling and processing of produce, quality components and industrial uses of the main and by products.	4
7	**Chickpea**: Importance, origin, production and distribution, classification, morphology and phenology, cropping systems, adaptability, climate, soil and cultural requirement for maximization of production and improved varieties, Nutrient water and weed management, crop protection, handling and processing of produce.	3
8.	**Pigeon pea**: Importance, origin, protection and distribution, classification, morphology and phenology, cropping systems, Adaptability, climate, soil and improved varieties, Nutrient, water and weed management, crop protection, handling and processing of produce.	3

Lecture Schedule – Practical

S.No	Topic	No. of lectures
1	Phenological studies at different growth stages of crops	1
2	Methods of raising nursery including dapog in paddy	1
3	Calculation of fertilizer requirements on the basis of soil test values	1
4	Computation of cost of cultivation in crops	1
5	Formulation of cropping schemes for various farm sizes and calculation of cropping and rotation intensities	2
6	Planning and layout of field experiments	1
7	Working out of indices of intercropping systems – LER aggressivity, relative crowding coefficient, monetary yield advantage and ATER	1
8	Determination of physiological maturity in different crops	1
9	Working out of harvest index in various crops	1
10	Computation of growth analysis indices	1
11	Visit of field experiments on cultural, fertilizer, weed control and water management aspects	1
12	Study of yield attributing characters of cereals and pulses, computation of yield on the basis of yield attributing characters.	1
13	Study of pattern and morphology of root nodules in pulses and seed treatment of pulses and grain legumes with Rhizobium culture	1
14	Estimation of protein in pulses	1
15	Interculture operations in various crops	1

Suggested Readings :

Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.

Hunsigi G & Krishna KR. 1998. *Science of Field Crop Production*. Oxford & IBH.

Khare D &Bhale MS. 2000. *Seed Technology*. Scientific Publ.

Kumar Ranjeet& Singh NP. 2003. *Maize Production in India: Golden Grain in Transition*. IARI, New Delhi.

Pal M, Deka J &Rai RK. 1996. *Fundamentals of Cereal Crop Production*.TataMcGrawHill.

Prasad, Rajendra. 2002. *Text Book of Field Crop Production*. ICAR.

B.N. Chatterjee and K.K. Bhattacharya, 1986. Principles and Practices of Grain Legume Production, Oxford & IBH Publishing Company, New Delhi.

Jeswani and Baldev, 1990. Advances in Pulse Production Technology, ICAR Publication, New Del hi. Singh C., Singh Prem and Singh Rajbir, 2003. Modern Techniques of Raising Field Crops. Oxford & IBH Publishing Co., New Delhi.

Singh, SS. 1998. *Crop Management*. Kalyani publishers

P.S. Rathore 2000. Techniques and Management of Field Crop Production. Agrobios (India) Jodhpur.

D.S. Yadav, 1992. Pulse Crops, Kalyani Publishers, New Delhi

03MAGR102 Agronomy of Oilseeds, Fibre and Commercial Crops 3(2+1)

Objective

To teach the crop husbandry of oilseed, fibre and commercial crops.

Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition quality component, handling and processing of the produce for maximum production of oilseeds - groundnut, rapeseed and mustard and soybean; fibre crops - cotton and jute and commercial crops-sugarcane and potato.

Practical

Phenological studies at different growth stages of crops, study of yield attributing characters of oilseeds and cotton; computation of yield on the basis of yield attributing characters; determination ofprotein and oil content in oilseeds, Seed treatment of cotton seed with sulphuric acid and cow dung; computation of cost of cultivation of various crops; determination of quality of cotton including ginning per cent and lint index; calculation of fertilizer requirements and their application at different growth stages in various crops on the basis of soil test values.

cutting of cane setts, its treatment and method of sowing, tying and propping of sugarcane; determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in juice; preparation of blue print for sugarcane, calculation of seed rate and fertilizer requirement for sugarcane; to work out the cost of cultivation of sugarcane; selection of potato seed, its treatment and method of sowing; calculation of seed rate and fertilizer requirement for potato; preparation of blue print for potato.

Lecture schedule – Theory

S.No.	Topic	No. of lectures
1	**Groundnut:** Importance,origin, history, production and distribution, classification, morphology, branching, cropping systems, Adaptability, climate, soil and cultural requirement for maximization of production and improved varieties, Nutrient, water and weed management in relation to latest research, pegging, Crop protection, handling and processing of produce, quality components.	4
2	**Rapeseed and mustard :**Importance , origin, history, production and distribution, classification, morphology, cropping systems, Adaptability, climate, soil and cultural requirements and improved varieties, Nutrient, water and weed management , Crop protection, handling and processing of produce, quality components	3
3	**Soybean** :Importance, origin, history, production and distribution, cropping systems, adaptability, climate, soil and cultural requirement for maximization of production and improved varieties, Nutrient water and weed management, Crop protection, handling and processing of produce, quality components.	3
4	**Cotton** :Importance, origin, history, production and distribution, classification, morphology, branching, cropping systems,Adaptability, climate, soil and cultural requirements for maximization of production and improved varieties. Nutrient, water and weed management in relation to latest research. Crop protection, handling and processing of produce, fibre quality, boll shedding and correction, BT Cotton	4
5	**Jute** :Importance, origin, history, production and distribution, classification, morphology, Adaptability, climate, soil and cultural requirement and improved varieties, Nutrient, water and weed management ,crop protection, harvesting, retting and extraction.	3
6	**Sugarcane:** Origin, history, importance, distribution and adaptation, Classification, morphology and phenology , General production constraints and varietal improvement, climate, soil, sowing methods and Seed treatment Fertilizer management and Crop logging, Intercultivation, irrigation and weed control, ripening and harvesting, Ratoon management, Sugarcane quality and factors affecting, Disease, insect and pest management, Post harvest handling for marketing; industrial uses of main and by products	9
7	**Potato**: Origin, history, importance, distribution and adaption, classification, morphology and phenology, Climate, soil, sowing methods, varities, selection of seed and its treatment and fertilizer management, intercultivation, irrigation, weed control, seed plot technique in potato, Harvesting, post harvest care and grading, quality factors of potato, scope of true potato seed and its production technology.	6

Lecture schedule - Practical

S.No.	Topic	No. of lectures
1	Study of yield attributing characters of oilseeds, cotton and jute, computation of yield on the basis of yield attributing characters.	1
2	Determination of oil content in oilseeds and computation of oil yield	1
3	Seed treatment of cotton seed with sulphuric acid and cow dung	1
4.	Estimation of protein in oilseed crops	1
5.	Determination of quality of cotton including ginning % and lint index	1
6	Calculation of fertilizer requirements and their application at different growth stages in various crops on the basis of soil test values	1
7	Phenological studies in sugarcane	1
8	Cutting of cane setts, its treatment and method of sowing	1
9	Tying and propping of sugarcane	1
10	Determination of cane maturity and calculation on purity, recovery and sucrose content in juice	1
11	Calculation of seed rate and fertilizer requirement of sugarcane	1
12	Working out cost of cultivation of sugarcane crop	1
13.	Preparation of blue print of sugarcane and potato	1
14.	Phenological studies in potato	1
15.	Selection of potato seed, its treatment and method of sowing	1
16.	Calculation of seed rate and fertilizer requirement for potato	1

Suggested Readings:

Das, N.R. 2007. Introduction to crops of India. Scientific Publisher, Jodhpur.

H.C. Srivastava, S. Bhaskaran, B. Vatsyas and K.K.G. MENon, 1985. Oilseed Production : Constraints and Opportunities, Oxford & IBH Company, New Delhi.

Research and Development Strategies for Oilseed Production in India, 1979. Proceedings of National Symposium, 7-9 Nov. 1979, ICAR Publication, New Delhi.

P.S. Reddy, 1988. Groundnut, ICAR, New Delhi.

Chhidda Singh, Prem Singh and Rajbir Singh, 2003. Modern Techniques of Raising Field Crops. Oxford & IBH Publishing Co., New Delhi.

B.C. Biswas, S. Maheshwari, C. Singh and D.S. Yadav 1984. Cotton, Published by Fertilizer Association of India, New Delhi.

S.S. Singh, 1988. Crop Management under Irrigated and Rainfed Conditions, Kalyani Publishers, New Delhi.

P.S. Rathore 2000. Techniques and Management of Field Crop Production. . Agrobios (India) Jodhpur

Rajendra Prasad, 2002. Text book of field crops production ICAR Pub.

S.C. Verma and M.P. Singh, 1987. Agronomy of New Plant Types, Text Book Agenmcy, Varanasi.

P.S. Bhatnagar and S.P. Tiwari, 1990. Technology for increasing soybean production in India, NRCS, Technical Bulletin (ICAR), National Research Centre for Soybean, Indore.

S.S.Srivastava, D.P.Johari and S.S. Gill. 1988. Manual of Sugarcane Production in India. ICAR Publication, New Delhi.

J.S.Grewal, R.C.Sharma, S.S.Saini. 1991. Agro-techniques for Intensive Potato Cultivation in India, ICAR Publication, New Delhi.

J.S.Grewal&V.P.Jaiswal. 1990. Agronomical studies in potato under all India Coordinated Potato Improvement Project, CPRI Pub.Shimla.

R.L.Yadav. Agronomy of Sugarcane – Principles and Practices.

B. Sundara 1998. Sugarcane cultivation. Vikas Publishing House Pvt. Ltd.

03MAGR103 Hormonal Regulation of Plant Growth and Development 3(2+1)

Objective

To apprise the students about structure function of plant growth regulator on growth and development of plant.

Theory

Definition and classifiacation of palnt growth regulators- Hormones, endogenous growth substances and synthetic chemicals, Endogenous growth regulating substances other than hormones. tricontanol, Phenols – polyamines, jasmonates, concept of death hormone.Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- Auxins, Gibberlins, cytokinins, Abscisic acid and Ethylene Brassinosteroids. Signal perception.transduction, and effect at functional gene level of different hormones - Auxins- cell elongation, Gibberellins -, germination of dormant seeds, cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid-Stomatal closure and induction of drought resistance, Ethylene- fruit ripening. Interaction of hormones in regulation of plant growth and development processes. Rooting of cuttings - Flowering. Apical dominance, molecular aspects of control of reproductive growth and development. Synthetic growth regulators- Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

Practical

Extraction of hormones from plant tissue. Auxins- bioassays- auxins effect on rooting of cuttings, abscission, apical dominance, Gibberellins- bioassays-GA effect on germination of dormant seeds, cytokinin- bioassays- cytokinin effect on apical dominance and senescence, ABA bioassaysestimation. ABA effect on stomatal movement, Ethylene bioassays, estimation using physico chemical techniques (with the condition that GLC/ HPLC is provided) - effect of hormones on breaking dormancy.

Lecture schedule--Theory

S.No.	Topic	No. of lectures
1	Definition and classification of plant growth regulators- Hormones,	2
2	Endogenous growth substances and synthetic chemicals	2
3	Endogenous growth regulating substances other than hormones. tricontanol, Phenols – polyamines, jasmonates, concept of death hormone.	3
4	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones- Auxins	1
5	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones- Gibberlins	1
6	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- and cytokinins	1
7	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones-. Abscisic acid	1
8	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones- Ethylene	1
9	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones- brassinosteroids	2
10	Signal perception. Transduction and effect at functional gene level of different hormones Auxins- cell elongation, Gibberellins-, germination of dormant seeds.	3
11	Signal perception. Transduction and effect at functional gene level of different hormones cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid- stomatal closure and induction of drought resistance, Ethylene- fruit ripening.	3
12	Interaction of hormones in regulation of plant growth and development processes. Rooting of cuttings- Flowering. Apical dominance.	3
13	Molecular aspects of control of reproductive growth and development.	3
14	Synthetic growth regulators- Classification, their effect on plant growth and development.	3
15	Practical utility of Synthetic growth regulators agriculture and horticulture.	3

Lecture schedule--Practical

S.No.	Topic	No. of lectures
1	Extraction of hormones from plant tissue.	5
2	Auxins- bioassays- auxins effect on rooting of cuttings, abscission, apical dominance	2
3	Gibberellins- bioassays-GA effect on germination of dormant seeds,	2
4	Cytokines- bioassays- cytokinin effect on apical dominance and senescence,	2
5	ABA bioassays estimation. ABA effect on stomatal movement,	2
6	Ethylene bioassays, effect of hormones on breaking dormancy	2
7	Estimation of PGRs using physico chemical techniques (with the condition that GLC/ HPLC is provided)	3

Suggested Readings

Hopkins WG &Huner NPA. 2004. *Introduction to Plant Physiology*. John Wiley & Sons.
Salisbury FB & Ross C. 1992.*Plant Physiology*. 4th Ed. Wadsworth Publ.

03MAGR104Management of Problem Soils and Waters3(2+1)

Objective

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible, morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties, management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils, acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management, quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality, agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical

Characterization of acid, acid sulfate, salt-affected and calcareous soils, determination of cations (Na^{+}, K^{+}, Ca^{++} and Mg^{++}) in ground water and soil, samples, determination of anions (Cl^{-}, $SO4^{--}$, $CO3^{--}$ and $HCO3^{-}$) in ground waters and soil samples, lime requirements of acid soil and gypsum requirements of sodic soil.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils	2
2.	Origin and basic concept of problematic soils, and factors responsible	3
3.	Morphological features of saline, sodic and saline-sodic soils	2
4.	Characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties	2
5.	Management of salt-affected soils	2
6.	Salt tolerance of crops - mechanism and ratings	2
7.	Monitoring of soil salinity in the field	1
8.	Management principles for sandy, clayey, red lateritic and dry land soils	3
9.	Acid soils - nature of soil acidity, sources of soil acidity	1
10.	Soil acidity effect on plant growth and lime requirement of acid soils	2
11.	Management of acid and acid sulphate soils	2
12.	Biological sickness of soils and its management	2
13.	Quality of irrigation water and their crop response	2
14.	Management of brackish water for irrigation	2
15.	Salt balance under irrigation	1
16.	Characterization of brackish waters, area and extent, relationship in water use and quality	3

Lecture schedule—Practical

S. No.	Topic	No. of lecture
1.	Characterization of acid and acid sulfate soils salt-affected and calcareous soils	**1**
2.	Characterization of salt-affected soils	**1**
3.	Characterization of calcareous soils	**1**
4.	Determination of Ca^{++} and Mg^{++} in soil	**1**
5.	Determination of Ca^{++} and Mg^{++} in ground water	**1**
6.	Determination of Potassium in ground water	**1**
7.	Determination of Potassium in soil	**1**
8.	Determination of sodium in ground water	**1**
9.	Determination of sodium in soil	**1**
10.	Determination of $CO3^{--}$ and $HCO3^{-}$ in ground waters	**1**
11.	Determination of $CO3^{--}$ and $HCO3^{-}$ in soil	**1**
12.	Determination of chloride in ground waters	**1**
13.	Determination of chloride soil	**1**
14.	Determination of sulphate ($SO4^{--}$) in ground waters	**1**
15.	Determination of sulphate ($SO4^{--}$) in soil	**1**
16.	Determination of gypsum requirement of sodic soil	**1**
17.	Determination of lime requirement of acid soil	**1**

Suggested Readings

Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.

Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.

USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline andAlkali Soils*. Oxford & IBH.

BHAGWANT UNIVERSITY

Established by Govt. of Raj. & Recognised by UGC

Sikar Road, Ajmer

RAJASTHAN

Syllabus

M.Sc. (Horticulture)

Faculty of Agriculture

Bhagwant University, Ajmer (Raj.)

M.Sc. (Ag.) Course Programs

HORTICULTURE

Semester I			
BU COURSE NO.	**ICAR Course No**	**Course Title**	**Credit Hours**
01MHOR101	**HORT 511**	Tropical and dry Land Horticulture	**3(2+1)**
01MHOR102	**HORT 512**	Sub- Tropical and Temperate Fruit Production	**3(2+1)**
01MHOR103	**HORT 513**	Production Technology of Warn season Vegetable Crops	**3(2+1)**
01MHOR104	**SOIL 513**	Analytical techniques and instrumental methods in soil and plant analysis	**3(1+2)**
Semester II			
02MHOR101	**HORT 521**	Seed Production Technology of Vegetable crops	**3(2+1)**
02MHOR102	**HORT 522**	Propagation and Nursery Management of Fruit Crops	**3(2+1)**
02MHOR103	**HORT 527**	Landscaping and Ornamental Gardening	**3(2+1)**
02MHOR104	**STAT 521**	Experimental design	**3(2+1)**
Semester III			
03MHOR101	**HORT 531**	Production Technology of loose Flowers	**3(2+1)**
03MHOR102	**HORT 532**	Post Harvest Technology for Fruit Crops	**3(2+1)**
03MHOR103	**HORT 533**	Production Technology of cool season vegetable crops	**3(2+1)**
03MHOR104	**PPHYS 531**	Hormonal regulation of plant growth and development	**3(2+1)**
03MHOR105	**SOIL 532**	Management of problem soils and waters	**3(2+1)**
Semester IV			
04MHOR101	**HORT 541**	M.Sc. Seminar	**1(0+1)**
04MHOR102	**HORT 542**	Comprehensive	**2(0+2)**
04MHOR103	**HORT 543**	M.Sc. Research	**15**
		Total	**56**

01MHOR101 Tropical and Dry Land Fruit Production 3(2+1)

Objective

To impart basic knowledge about the importance and management of tropical and dry land fruits grown in India.

Theory

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bio regulators, abiotic factors limiting fruit production, physiology of flowering, pollination, fruit set and development, honeybees in cross pollination, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.

Crops

Mango and Banana, Papaya, Coconut and Cashew nut, Sapota and Jackfruit, Pineapple and Annonas , Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics (Mahua, Lasoda, Mulberry, Tamarind and Chironji)

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation,malady diagnosis, analyses of quality attributes, Practices of important agro-techniques, visit to tropical andarid zone orchards, Project preparation for establishing commercial orchards.

Lecture schedule: Theory

S.No.	Topic	No. of lecture
1.	Commercial varieties of regional , national and international importance, ecophysiological requriment, recent trends in propagation, rootstock influence, planting system, cropping system, root zone and canopy management, nutrient management, water management, fertigation, role of bio regulators, abiotic factors limiting fruit pdiduction, physiology of flowering , pollination, fruit set and development, honeybees in cross pollination, physiological disorder-causes and remedies, quality improvement by management practices, maturity indices, harvesting, grading, packing, storage and ripening techniques, industrial and export potential, Agri. Export Zones (AEZ) and industrial supports.- Mango	5
2.	Banana	4
3.	Papaya	2
4.	Coconut	2
5.	Cashew nut	2
6.	Sapota	2
7.	Jackfruit	1
8.	Pinaapple	2
9.	Annonas	2
10.	Aonla	2
11.	Pomegranate	1
12.	Phalsa	1
13.	Ber	2
14.	Mahua	1
15.	Lasoda	1
16.	Mulberry	1
17.	Tamarind	1

18.	Chironji	1

Lecture schedule: Practical

S. No	Topic	No of lectures
1.	Identification of important cultivars	2
2.	Observation on growth and development	2
3.	Practices in growth regulation	2
4.	Malady diagnosis in fruit crops	2
5.	Analyses of quality attributes	2
6.	Practices of important agro- techniques- fertilization, manuring, weeding and hoeing pruning and training	3
7.	Visit to tropical and arid zone orchard	2
8.	Project preparation for establishing commercial orchards	2

Suggested Readings

Bose, TK,Mitra,SK & Rathore, DS. (Eds.). 1988. *Temperate Fruits - Horticulture*.Allied Publ.
Bose, T.K, Mitra, S.K & Sanyal, D. 2001. (Eds.). *Fruits -Tropical and Subtropical*. Naya Udyog.
Chadha, K.L & Pareek, O.P. 1996. (Eds.). *Advances in Horticulture*. Vols. II- IV. Malhotra Publ. House. Nakasone, H.Y & Paul, R.E. 1998. *Tropical Fruits*. CABI.
Peter, K.V. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency.
Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan, K.N. 2008. *Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.
Radha, T & Mathew, L. 2007. *Fruit Crops*. New India Publ. Agency.
Singh, H.P, Negi JP & Samuel JC. (Eds.). 2002. *Approaches for Sustainable Development of Horticulture*. National
Horticultural Board.
Singh,H.P, Singh G, Samuel,J.C & Pathak R.K. (Eds.). 2003. *Precision Farming in Horticulture*. NCPAH, DAC/PFDC, CISH, Lucknow.

01MHOR102 Subtropical and Temperate Fruit Production 3(2+1)

Objective

To impart basic knowledge about the importance and management of subtropical and temperate fruits grown in India.

Theory

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bio regulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, pre-cooling, storage, transportation and ripening techniques; industrial and export
potential, Agri Export Zones(AEZ) and industrial support.

Crops- Apple, pear, quince, Plums, peach, apricot, cherries, Litchi, loquat, kiwifruit, strawberry Nuts- walnut, almond, pistachio, Grapes, Guava, Citrus and Custard apple, Minor fruits- carambola, bael, wood apple, fig, jamun, rambutan, ker, pilu

Practical

Identification of important fruit plants and its available cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, Project preparation for establishing commercial orchards.

Lecture schedule: Theory

S.No	Topic	No. of lecture
1	Commercial varieties of regional, national and international importance, cophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water anagement, fertigation, role of bio regulators, abiotic factors limiting fruit production, physiology of flowering, pollination, fruit set and development, honeybees in cross pollination, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports of following fruit crops.	
2	Apple, pear, quince	6
3	Plums, peach, apricot, cherries	4
4	Litchi, loquat, kiwifruit, strawberry	4
5	Nuts- walnut, almond, pistachio	4
6	Grapes, Guava, Citrus and Custard apple	6
7	Minor fruits- carambola, bael, wood apple, fig, jamun, rambutan, ker, pilu	8

Lecture schedule: Practical

S. No	Topic	No. of lecture
1	Identification of important fruit plants and its available cultivars	2
2	Observations on growth and development of Tropical, sub- tropical & temperate fruit crops	2
3	Practices in growth regulation and canopy management in fruit crops	4
4	Diagnosis of different malady / disorders & analyses of quality attributes	4
5	Practices of important agro-techniques of tropical, sub- tropical & temperate fruit crops.	2
6	Visit to tropical, sub- tropical & temperate fruit crops.	2

Suggested Readings

Bose T.K, Mitra S.K & Sanyal D. (Ed.). 2002. *Fruits of India — Tropical and Sub-tropical*. 3 rd Naya Udyog.

Chadha K.L & Pareek O.P. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House. Ed. Vols. I, II.

Chadha K.L & Shikhamany S.D. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.

Janick J & Moore J.N. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.

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

01MHOR103 Production Technology of Warm Season Vegetable Crops 3(2+1)

Objective

To teach production technology of warm season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids,sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of: Tomato, eggplant, hot and sweet peppers, Okra, beans, cowpea and clusterbean, Cucurbitaceous crops , Colocasia and sweet potato, Green leafy warm season vegetables.

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments to demonstrate the role of mineral elements, physiological disorders; plant growth substances and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

Lecture schedule: Theory

S.No	Topic	No. of lecture
1.	Introduction,botany & taxonomy,climate and soil requirement,commercial varieties/hybrids,sowing/planting times &methods,seed rate and seed treatment,nutritional and irrigation requirement,intercultural operations,weed control,mulching,physiological disorder,harvesting,post-harvesting management,plant protection measures,economics of crop production and seed production of - Tomato	4
2.	Eggplant	3
3.	Hot and sweet peppers	3
4.	Okra	1
5.	Beans	2
6.	Cowpea	1
7.	Cluster Bean	1
8.	Cucurbitaceous crops- Water melon	1
9.	Musk melon	1
10.	Bottle gourd	1
11.	Ridge gourd	1
12.	Round gourd	1
13.	Kakri	1
14.	Bitter gourd	1
15.	Little gourd	1
16.	Smooth gourd	1
17.	Snap gourd	1
18.	Kachari	1
19.	Khira	1
20.	Kaddu	1
21.	Colocasia	2
22.	Sweet potato	1
23.	Green leafy warm season vegetables	1

Lecture schedule: Practical

S.No	**Topic**	**No. of lecture**
1.	Cultural operations (fertilizer application, sowing,mulching)	1
2.	Cultural operations (irrigation and weed control) of summer vegetables crops	1
3.	Economic of summer veg, crops	1
4	Study of physiological and deficiency of mineral elements	2
5.	Preparation of cropping schemes for commercial farms	1
6.	Experiments to demonstrate the role of mineral element physiological disorder	1
7.	Experiments to demonstrate the physiological disorder	1
8.	Experiments to demonstrate the plant growth substances	1
9	Experiments to demonstrate the herbicides	1

10	Experiments to demonstrate the seed extraction techniques	1
11.	Identification of important pests and their control	1
12	Identification of important diseases and their control	1
13.	Maturity standard of warm season vegetables crops	1
14	Economics of warm season vegetable crops	2

Suggested Readings

Bose T.K & Som M.G. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.
Bose T.K, Kabir J, Maity T.K, Parthasarathy V.A & Som M.G. 2003. *Vegetable Crops*. yols. I-III. NayaUdyog.
Bose T.K, Som M.G & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash. Brown H.D & Hutchison C.S. *Vegetable Science*. JB Lippincott Co.
Chadha K.L & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture*. vols. V-X. Malhotra Publ. House. Chadha K.L. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
Chauhan D.V.S. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons. Decoteau D.R. 2000. *Vegetable Crops*. Prentice Hall.
Edmond J.B, Musser A.M & Andrews F.S. 1964. *Fundamentals of Horticulture*. Blakiston Co
Fageria M.S, Choudhary B.R & Dhaka R.S. 2000. *Vegetable Crops: Production Technology*. vol. II.Kalyani.
Gopalakrishanan T.R. 2007. *Vegetable Crops*. New India Publ. Agency.
Hazra P & Som M.G. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.
Kalloo G & Singh K (Ed.). 2000. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.
Nayer N.M & More TA 1998. *Cucurbits*. Oxford & IBH Publ. Palaniswamy & Peter Ky. 2007. *Tuber Crops*. New India Publ. Agency.
Pandey A.K & Mudranalay y. (Eds.). *Vegetable Production in India: Important Varieties and Development Techniques.*
Rana M.K. 2008. *Olericulture in India*. Kalyani.

01MHOR104 Analytical techniques and instrumental methods in soil and plant analysis 3(1+2)

Objective

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Theory

Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods.

Practical

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils. Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity, analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of

plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods, drawing normalized exchange isotherms; measurement of redox potential.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Principles of visible, ultraviolet and infrared spectrophotometery	2
2.	Principle and instrumentation of atomic absorption spectrophotometer	2
3.	Principles of flame-photometry	1
4.	Principles and instrumentation of inductively coupled plasma spectrometry	2
5.	Principles and instrumentation of chromatographic techniques	4
6.	Principles of mass spectrometry and X-ray defractrometery	2
7.	Principle of identification of minerals by X-ray by different Methods	3

Lecture schedule—Practical

S.No	Topic	No. of lecture
1.	Analytical chemistry – Basic concepts, techniques and calculations	3
2.	Principle of analytical instruments and their calibration for soil and plant analysis	2
3.	Determination of available nitrogen in soil	1
4.	Determination of available phosphorus in soil	1
5.	Determination of available potassium in soil	1
6.	Determination of available sulphur in soil	1
7.	Determination of available Boron in soil	1
8.	Determination of available molybdenum in soil	1
9.	Determination of iron, cupper, manganese and zinc in soil	1
10.	Determination of potential buffering capacity of phosphorus	1
11.	Determination of potential buffering capacity of potassium	1
12.	Determination of ammonium fixation capacity of soil	1
13.	Determination of potassium fixation capacity of soil	1
14.	Determination the cation exchange capacity of soil	1
15.	Determination the anion exchange capacity of soil	1
16.	Determination of calcium and magnesium in soil	1
17.	Determination of Sodium in soil	1
18.	Estimation of root cation exchange capacity	1
19.	Determination of nitrogen in plant	1
20.	Determination of phosphorus in plant	1
21.	Determination of potassium in plant	1
22.	Determination of sulphur in plant	1
23.	Determination of calcium and magnesium in plant	1
24.	Determination of boron in plant	1
25.	Determination of molybdenum in plant	1
26.	Determination of iron, cupper, manganese and zinc in plant	1
27.	Estimation of root cation exchange capacity	1
28.	Drawing normalized exchange isotherms; measurement of redox potential	2

Suggested Readings

Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons. Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.

Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.

Kenneth Helrich 1990. *Official Methods of Analysis* Association of Official Analytical Chemists. Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison. Piper CE. *Soil and Plant Analysis*. Hans Publ.

Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis – A Methods Manual*. IARI, New Delhi. Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.

Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi. Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis.* ELBS Longman

02MHOR101Seed Production Technology of Vegetable Crops 3(2+1)

Objective

To educate principles and methods of quality seed and planting material production in vegetable crops.

Theory

Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India. Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production. Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control. Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology. Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra.

Practical

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; rouging of off-type; methods of hybrid seed production in important vegetable and spice crops; seed extraction techniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

Lecture schedule: Theory

S.No.	Topic	No. of lecture
1.	Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India.	2
2.	Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production.	2
3.	Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.	2
4.	Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.	2
5.	Agro-techniques for seed production in potato	2
6.	Tomato	2
7.	Brinjal	2
8.	Chilli	2
9.	Cauliflower	1
10.	Cabbage	1
11.	Knol - khol	1
12.	Sprouting broccoli	1
13.	Brussels sprout	1
14.	Okra	1
15.	Cucurbitaceous crops	2
16.	Onion	1
17.	Garlic	1
18.	Pea	1
19.	Broad bean	1
20.	Cluster bean	1
21	Cow pea	1

22	Palak	1
23	Amarnthus	1
24	Fenugreek	1

Lecture schedule: Practical

S.No	Topic	No. of lecture
1.	Seed sampling	2
2.	Seed testing (genetic purity, seed viability	2
3.	Seed viability	2
4	Seedling vigour	2
5.	Physical purity) and seed health testing	2
6.	Releasing and notification procedures of varieties	2
7.	Floral biology	2
8.	Rouging	2

Suggested Readings

Agrawal P.K & Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ. Agrawal R.L. (Ed.). 1997. *Seed Technology*. Oxford & IBH.
Bendell P.E. (Ed.). 1998. *Seed Science and Technology: Indian Forestry Species*. Allied Publ.
Fageria M.S, Arya P.S & Choudhary A.K. 2000. *Vegetable Crops: Breeding and Seed Production*. vol. I. Kalyani. George RAT. 1999. *Vegetable Seed Production*. 2nd Ed. CABI.
Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ. More T.A, Kale P.B & Khule B.W. 1996. *Vegetable Seed production Technology*. Maharashtra State SeedCorp.
Rajan S & Baby L Markose. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.
Singh N.P, Singh D.K, Singh Y.K & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distributing Co.
Singh S.P. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

02MHOR102 Propagation and Nursery Management for Fruit Crops 3(2+1)

Objective

Familiarization with principles and practices of propagation and nursery management for fruit crops.

Theory

Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth. Seed quality, treatment, packing, storage, certification, testing. Asexual propagation — rooting of cuttings. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering — principle and methods. Budding and grafting - selection of elite mother plants, methods . Establishment of bud wood bank, stock, scion and inter stock, relationship — Incompatibility. Rejuvenation through top working — Progeny orchard and scion bank. Micro-propagation— principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micro grafting, meristem culture. Hardening, packing and transport

of micro-propagules, shoot tip grafting/ micro grafting. Nursery — types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

Practical

Preparation and planting of cuttings and layering, Root stock raising, Practices of different methods of budding and grafting, Study of media and PGR. Hardening, micropropagation, explant preparation, media preparation, culturing — *in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening. Visit to TC labs and nurseries.

Lecture schedule: Theory

S. No.	Topic	No. of lecture
1	Introduction, life cycles in plants	1
2	Cellular basis for propagation in fruit crops.	1
3	Sexual propagation, apomixis, polyembryony, chimeras.	2
4	Principal factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.	2
5	Seed quality, treatment, packing, storage, certification, testing	2
6	Asexual propagation — rooting of cuttings.	3
7	Physiological, anatomical and biochemical aspects of root induction in cuttings.	2
8	Layering — principle and methods.	2
9	Budding and grafting - selection of elite mother plants , methods .	2
10	Establishment of bud wood bank, stock, scion and inter stock, relationship — Incompatibility.	2
11	Rejuvenation through top working — Progeny orchard and scion bank.	2
12	Micro-propagation— principles and concepts, commercial exploitation in horticultural crops .	2
13	Techniques - in vitro clonal propagation , direct organogenesis, embryogenesis, micro grafting, meristem culture	2
14	Hardening, packing and transport of micro-propagules, shoot tip grafting/ micro grafting.	2
15	Nursery — types, structures, components, planning and layout.	2
16	Nursery management practices for healthy propagule production	3

Lecture schedule: Practical

1	Preparation and planting of cuttings and layering	2
2	Raising of root stock.	2
3	Practices of different methods of budding and grafting	4
4	Study of media and PGR	2
5	Hardening, micro propagation, explant preparation, media preparation	2
6	*In vitro clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct* organogenesis, direct and indirect embryogenesis, micro grafting, hardening.	2
7	Visit to TC labs and nurseries.	2

Suggested Readings

Hartmann H.T & Kester D.E. 1989. *Plant Propagation — Principles and Practices*. Prentice Hall of India.

Bose T.K, Mitra S.K & Sadhu M.K. 1991. *Propagation of Tropical and Subtropical Horticultural Crops*. Naya Prokash.

Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency. Singh SP. 1989 *Mist Propagation*. Metropolitan Book Co.
Rajan S & Baby LM. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency. Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

02MHOR103 Landscaping and Ornamental Gardening 3(2+1)

Objective
Familiarization with principles and practices of landscaping and ornamental gardening.

Theory
Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Buddha garden; Styles of garden, formal, informal and free style gardens. Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates. Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves; Production technology for selected ornamental plants.Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves.Bio-aesthetic p l a n n i n g , eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.

Practical
Identification of ornamental plants**,** practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

S. No.	Topic	No. of lecture
1.	Scope of loose flower trade, Significance in the domestic market export	2
2.	Varietal wealth and diversity	1

3.	Propagation: Sexual and asexual propagation methods	3
4.	Propagation in mist chambers , nurser y management , pro -tray nursery under shade nets, transplanting techniques	2
5.	Soil and climate requirements, field preparation, systems of planting, precision farming techniques, Water and nutrient management, weed management, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, Flower forcing and year roundflowering, production for special occasions through physiological interventions, chemical regulation, Harvest indices, harvesting techniques, post-harvest handling and grading, pre- cooling, packing and storage, value addition, concrete and essential oil extraction, trasportation and marketing, export potential, institutional support, Agri Export Zones	
6.	Jasmine	2
7.	Scented rose	3
8.	Chrysanthemum	3
9.	Marigold	1
10	Tuberose	1
11	Crossandra	1
12	Nerium	1
13	Hibiscus	1
14	Barleria	1
15	Gomphrena	1
16	Gaillardia	1
17	Nyctanthes	1
18	Tabernaemontana	1
19	Ixora,	1
20	Lotus	1
21	Lilies	1
22	Tecoma	1
23	Champaka	1
24	Pandanus	1

Lecture schedule: Practical

S. No.	**Topic**	**No. of lecture**
1	Botanical description of species and varieties	1
2	Propagation techniques	2
3	Mist chamber operation	1
4	Training and pruning techniques	1
5	Practices in manuring, drip and fertigation, foliar nutrition,	2
6	Growth regulator application	1
7	Pinching, disbudding, staking	1
8	Harvesting techniques	1
9	Post-harvest handling,	1
10	Storage and cold chain,	1
11	Project preparation for regionally important commercial loose flowers	2
12	Essential oil extraction units and markets	1
13	Visits to fields	1

Suggested Readings

Bose T.K, Maiti R.G, Dhua R.S & Das P.1999. *Floriculture and Landscaping.* Naya Prakash.
Lauria A & Yictor H.R. 2001. *Floriculture — Fundamentals and Practices* Agrobios. Nambisan K.M.P.1992. *Design Elements of Landscape Gardening*. Oxford & IBH. Randhawa G.S & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
Sabina G.T & Peter K.Y. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.

02MHOR104 Experimental Designs 3(2+1)

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. 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

Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control, Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design, Factorial experiments, (symmetrical as well as asymmetrical), orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment, 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, resolvable designs and their applications ~ concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

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; Analysis of resolvable designs; Fitting of response surfaces.

Lecture schedule: Theory

S. No.	Topics	No. of Lect.
1.	Basic concepts of design of experiment	2
2.	Basic principles of designs	3
3.	Uniformity trials	1
4.	Size and shape of plots and blocks	1
5.	Analysis of variance and transformations	2
6.	CRD, RBD and LSD	3
7.	Factorial experiments	4
8.	Confounding in symmetrical factorial experiments	2
9.	Factorial experiments with control treatment	2
10.	Split plot design	2

11.	Strip plot design	2
12.	Analysis of covariance and missing plot techniques	2
13.	crossover designs	1
14.	resolvable designs	1
15.	Response surfaces	2
16.	Experiments with mixtures	2

Lecture schedule: Practical

S. N.	Topics	No. of Lectures
1.	Formation of plots	1
2.	Formation of blocks	1
3.	Analysis of CRD	1
4.	Analysis of RBD	1
5.	Analysis of LSD	1
6.	Analysis of factorial experiment	1
7.	Analysis of asymmetric factorial experiments	1
8.	Analysis of confounded factorial experiments	1
9.	Analysis with missing data in RBD	1
10.	Analysis with missing data in LSD	1
11.	Transformation of data	1
12.	Analysis of SPD	1
13.	Analysis of strip plot design	1
14.	Analysis of resolvable designs	1
15.	Fitting of response surfaces	2

References:

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

03MHOR101 Production Technology for Loose Flowers 3(2+1)

Objective

To impart basic knowledge about the importance and management of loose flowers grown in India.

Theory

Scope of loose flower trade, Significance in the domestic market export, varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers , nursery management , pro-tray nursery under shadenets, transplanting techniques Soil and climate requirements, field preparation, systems of planting, precision farming techniques. Water and nutrient management, weed management, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM. Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation. Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packing and storage, value addition, concrete and essential oil extraction, trasportation and marketing, export potential, institutional support, Agri Export Zones. **Crops:** Jasmine, scented rose, chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, gomphrena, gaillardia, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, lilies, tecoma, champaka, pandanus).

Practical

Botanical description of species and varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, storage and cold chain, project preparation for regionally important commercial loose flowers, visits to fields, essential oil extraction units and markets.

Lecture schedule: Theory

S. No.	Topic	No. of lecture
1	Landscape designs	1
2	Styles of garden, formal, informal and free style gardens	1
3	Mughal garden	1
4	English Garden	1
5	Japanese garden	1
6	Persian garden, Spanish garden, Italian & Buddha garden	2
7	Urban landscaping	1
8	Landscaping for specific situations: Institutions	1
9	Landscaping for specific situations: Industries	1
10	Landscaping for specific situations: Residents & hospitals, Roadsides, traffic islands, damsites	2
11	Landscaping for specific situations: IT parks & corporate	1
12	Garden plant components, arboretum	1
13	Shrubbery	1
14	Fernery, palmatum	1
15	Arches and pergolas	1
16	Edges and Hedges	1
17	Climbers and creepers	1
18	Cacti and succulents	1
19	Herbs, annuals, flower borders and beds	1
20	Ground covers, carpet beds, bamboo groves	1

21	Production technology for selected ornamental plant	1
22	Lawns: Establishment and maintenance	1
23	Special types of gardens: vertical garden, roof garden,	1
24	Bog garden, sunken garden	1
25	Rock garden, clock garden, colour wheels, temple garden, sacred groves	1
26	Bio-aesthetic planning,eco-tourism, theme parks	1
27	Indoor gardening	1
28	Therapeutic gardening, non-plant components	1
29	Water scaping	1
30	Xeriscaping & hardscaping	1

Lecture schedule: Practical

S. No.	Topic	No. of lecture
1	Identification of ornamental plants	2
2	Practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates	4
3	Avenue planting, practices in planning and planting of special types of gardens, burlapping	2
4	Lawn making	2
5	Planting herbaceous and shrubbery borders	1
6	Project preparation on landscaping for different situations	2
7	Visit to parks and botanical gardens	1
8	Case study on commercial landscape gardens	2

Suggested Readings

Arora J.S. 2006. *Introductory Ornamental Horticulture*. Kalyani.
Bhattacharjee S.K. 2006. *Advances in Ornamental Horticulture*. vols. I-VI. Pointer Publ. Bose T.K & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.
Bose T.K, Maiti R.G, Dhua R.S & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash. Chadha K.L & Chaudhury B.1992. *Ornamental Horticulture in India*. ICAR.
Chadha K.L. 1995. *Advances in Horticulture.* vol. XII. Malhotra Publ. House. Lauria A & Ries V.H. 2001. *Floriculture — Fundamentals and Practices.* Agrobios.
Prasad S & Kumar U. 2003. *Commercial Floriculture. A*grobios.
Randhawa G.S & Mukhopadhyay A. 1986. *Floriculture in India.* Allied Publ. Sheela V.L. 2007. *Flowers in Trade*. New India Publ. Agency.
Valsalakumari P.K, Rajeevan P.K, Sudhadevi P.K & Geetha C.K. 2008. *Flowering Trees*. New India Publ. Agency.

03MHOR102 Post Harvest Technology for Fruit Crops 3(2+1)

Objective

To facilitate deeper understanding on principles and practices of post- harvest management of fruit crops.

Theory

Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration. Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling. Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents

and natural plant products. Methods of storage- ventilated, refrigerated, MAS, CA storage, physical injuries and disorders. Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juice beverages, pickles, jam, jellies, sauces and ketchup, candies, preserve. Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of shelf life extension in cut flower using chemicals, estimation of quality characteristics in stored fruits and vegetables, practices of preservation by salt, sugar, vinegar and chemical preservatives, cold chain management - visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products.

Lecture schedule: Theory

S.No.	Topic	No. of lectures
1	Maturity indices,	2
2	harvesting practices for specific market requirements,	1
3	influence of pre-harvest practices,	2
4	enzymatic and textural changes, respiration, transpiration.	2
5	Physiology and biochemistry of fruit ripening	1
6	ethylene evolution and ethylene management,	1
7	factors leading to post-harvest loss.	1
8	Treatments prior to shipment, viz., pre-cooling, chlorination, waxing, chemicals, biocontrol agents and natural plant products.	2
9	Methods of storage- ventilated, refrigerated, MAS, CA storage	3
10	, physical injuries and disorders.	1
11	Packing methods and transport,	2
12	principles and methods of preservation, food processing,	2
13	canning,	1
14	fruit juice beverages,	1
15	pickles,	1
16	jam,	1
17	jellies,	1
18	sauces and ketchup,	1
19	Candies & preserve.	1
20	Dried and dehydrated products,	1
21	nutritionally enriched products,	1
22	fermented fruit beverages,	1
23	packaging technology, processing waste management,	1
24	Food safety standards.	1

Lecture schedule: Practical

S.No.	Topic	No. of lectures
1	Analyzing maturity stages of commercially important horticultural crops	1
2	improved packing and storage of important horticultural commodities	1
3	physiological loss in weight of fruits and vegetables	1
4	estimation of transpiration, respiration rate, ethylene release	2

5	study of shelf life extension in cut flower using chemicals	2
6	estimation of quality characteristics in stored fruits and vegetables	3
7	practices of preservation by salt, sugar, vinegar and chemical preservatives	2
8	cold chain management - visit to cold storage and CA storage units	1
9	visit to fruit and vegetable processing units	1
10	project preparation	1
11	evaluation of processed horticultural products	1

Suggested Readings

Bhutani R.C. 2003. *Fruit and Vegetable Preservation*. Biotech Books.

Chadha K.L & Pareek O.P. (Eds.). 1996 *Advances in Horticulture*. Vol. IV. Malhotra Publ. House.

Haid N.F & Salunkhe S.K. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ. Mitra S.K. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits*. CABI.

Ranganna S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.

Sudheer K.P & Indira V. 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.

Willis R, Mc Glassen W.B, Graham D & Joyce D. 1998. *Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.

03MHOR103 Production Technology of Cool Season Vegetable Crops 3(2+1)

Objective

To educate production technology of cool season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of: Potato ,Cole crops: cabbage, cauliflower, knol-kohl, sprouting broccoli, Brussels sprout, Root crops: carrot, radish, turnip and beetroot, Bulb crops: onion and garlic, Peas and broad bean, green leafy cool season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Experiments to demonstrate the role of mineral elements, plant growth substances and herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/ polyhouse.

Lecture schedule: Theory

S.No.	Topic	No. of lecture
1.	Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production	4
2.	Potato	2
3.	Cabbage	2
4.	Cauliflower	2
5.	Knol-kohl	1
6.	Sprouting broccoli	1
7.	Brussels sprout	1
8.	Onion	2
9.	Garlic	2
10.	Carrot	2
11.	Radish	2
12.	Turnip	1
13.	Beetroot	1
14.	Pea	2
15.	Broad bean	1
16.	Cluster bean	1
17	Cow pea	1
18	Palak	1
19	Amarnthus	1
20	Fenugreek	1

Lecture schedule: Practical

S.No	Topic	No. of lecture
1.	Identification of vegetable crops and seed.	2
2.	Fertilizer application in vegetable crops	1

3.	Seed treatment in vegetable crops	1
4.	Mulching in vegetable crops	1
5.	Irrigation management in vegetable crops	1
6.	Weed management in vegetable crops	1
7.	Role of mineral nutrition in vegetable crops	1
8.	Role of PGR's in vegetable crops	1
9.	Physiological disorders of cole crops	2
10.	Physiological disorders of bulb crops	2
11.	Physiological disorders of root crops	2
12.	Maturity standard of vegetable crops	1

Suggested Readings

Bose T.K & Som M.G. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.

Bose T.K, Som G & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.

Bose T.K, Som M.G & Kabir J. (Eds.). 1993. *Vegetable Crops*. Naya Prokash.

Bose T.K, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. vols. I-III. NayaUdyog.

Chadha K.L & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture* vols. V-X. Malhotra Publ. House. Chadha K.L. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.

Chauhan D.V.S. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons. Decoteau D.R. 2000. *Vegetable Crops*. Prentice Hall.

Edmond J.B, Musser A.M & Andrews F.S. 1951. *Fundamentals of Horticulture*. Blakiston Co.

Fageria M.S, Choudhary B.R & Dhaka R.S. 2000. *Vegetable Crops: Production Technology*. vol. II. Kalyani.

Gopalakrishanan T.R. 2007. *Vegetable Crops*. New India Publ. Agency.

Hazra P & Som MG. (Eds.). 1999. *Technology for v egetable Production and Improvement*. Naya Prokash. Rana M.K. 2008. *Olericulture in India*. Kalyani Publ.

Rana M.K. 2008. *Scientific Cultivation of Vegetables*. Kalyani Publ.

Rubatzky Y.E & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and NutritiveValues*. Chapman & Hall.

Saini G.S. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.

Salunkhe D.K & Kadam S.S. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.

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Singh D.K. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co. Singh S.P. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.

Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.

Thompson H.C & Kelly W.C. (Eds.). 1978. *Vegetable Crops*. Tata McGraw- Hill.

03MHOR104 Hormonal Regulation of Plant Growth and Development 3(2+1)

Objective

To apprise the students about structure function of plant growth regulator on growth and development of plant.

Theory

Definition and classifiacation of palnt growth regulators- Hormones, endogenous growth substances and synthetic chemicals, Endogenous growth regulating substances other than hormones. tricontanol, Phenols – polyamines, jasmonates, concept of death hormone.Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- Auxins, Gibberlins, cytokinins, Abscisic acid and Ethylene Brassinosteroids. Signal perception.transduction, and effect at functional gene level of different hormones - Auxins- cell elongation, Gibberellins -, germination of dormant seeds, cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid-Stomatal closure and induction of drought resistance, Ethylene- fruit ripening. Interaction of hormones in regulation of plant growth and development processes. Rooting of cuttings - Flowering. Apical dominance, molecular aspects of control of reproductive growth and development. Synthetic growth regulators- Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

Practical

Extraction of hormones from plant tissue. Auxins- bioassays- auxins effect on rooting of cuttings, abscission, apical dominance, Gibberellins- bioassays-GA effect on germination of dormant seeds, cytokinin- bioassays- cytokinin effect on apical dominance and senescence, ABA bioassaysestimation. ABA effect on stomatal movement, Ethylene bioassays, estimation using physico chemical techniques (with the condition that GLC/ HPLC is provided) - effect of hormones on breaking dormancy.

Lecture hedule--Theory

S.No.	Topic	No. of lectures
1	Definition and classification of plant growth regulators- Hormones,	2
2	Endogenous growth substances and synthetic chemicals	2
3	Endogenous growth regulating substances other than hormones. tricontanol, Phenols – polyamines, jasmonates, concept of death hormone.	3
4	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones- Auxins	1
5	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones- Gibberlins	1
6	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- and cytokinins	1
7	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones-. Abscisic acid	1
8	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones- Ethylene	1
9	Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones- brassinosteroids	2
10	Signal perception. Transduction and effect at functional gene level of different hormones Auxins- cell elongation, Gibberellins-, germination of dormant seeds.	3
11	Signal perception. Transduction and effect at functional gene level of different hormones cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid- stomatal closure and induction of drought resistance, Ethylene- fruit ripening.	3
12	Interaction of hormones in regulation of plant growth and development processes. Rooting of cuttings- Flowering. Apical dominance.	3
13	Molecular aspects of control of reproductive growth and development.	3
14	Synthetic growth regulators- Classification, their effect on plant growth and development.	3
15	Practical utility of Synthetic growth regulators agriculture and horticulture.	3

Lecture schedule--Practical

S.No.	Topic	No. of lectures
1	Extraction of hormones from plant tissue.	5
2	Auxins- bioassays- auxins effect on rooting of cuttings, abscission, apical dominance	2
3	Gibberellins- bioassays-GA effect on germination of dormant seeds,	2
4	Cytokines- bioassays- cytokinin effect on apical dominance and senescence,	2
5	ABA bioassays estimation. ABA effect on stomatal movement,	2
6	Ethylene bioassays, effect of hormones on breaking dormancy	2
7	Estimation of PGRs using physico chemical techniques (with the condition that GLC/ HPLC is provided)	3

Suggested Readings

Hopkins WG & Huner NPA. 2004. *Introduction to Plant Physiology*. John Wiley & Sons.
Salisbury FB & Ross C. 1992.*Plant Physiology.* 4th Ed. Wadsworth Publ.

03MHOR105 Management of Problem Soils and Waters 3(2+1)

Objective

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible, morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties, management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils, acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management, quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality, agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical

Characterization of acid, acid sulfate, salt-affected and calcareous soils, determination of cations (Na+, K+, Ca++ and Mg++) in ground water and soil, samples, determination of anions (Cl-, SO4--, CO3-- and HCO3-) in ground waters and soil samples, lime requirements of acid soil and gypsum requirements of sodic soil.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils	2
2.	Origin and basic concept of problematic soils, and factors responsible	3
3.	Morphological features of saline, sodic and saline-sodic soils	2
4.	Characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties	2
5.	Management of salt-affected soils	2
6.	Salt tolerance of crops - mechanism and ratings	2
7.	Monitoring of soil salinity in the field	1
8.	Management principles for sandy, clayey, red lateritic and dry land soils	3
9.	Acid soils - nature of soil acidity, sources of soil acidity	1
10.	Soil acidity effect on plant growth and lime requirement of acid soils	2
11.	Management of acid and acid sulphate soils	2
12.	Biological sickness of soils and its management	2
13.	Quality of irrigation water and their crop response	2
14.	Management of brackish water for irrigation	2
15.	Salt balance under irrigation	1
16.	Characterization of brackish waters, area and extent, relationship in water use and quality	3

Lecture schedule – practical

S. No.	Topic	No. of lecture
1.	Characterization of acid and acid sulfate soils salt-affected and calcareous soils	1
2.	Characterization of salt-affected soils	1
3.	Characterization of calcareous soils	1
4.	Determination of Ca++ and Mg++ in soil	1
5.	Determination of Ca++ and Mg++ in ground water	1
6.	Determination of Potassium in ground water	1
7.	Determination of Potassium in soil	1
8.	Determination of sodium in ground water	1
9.	Determination of sodium in soil	1
10	Determination of CO3-- and HCO3- in ground waters	1
11	Determination of CO3-- and HCO3- in soil	1
12	Determination of chloride in ground waters	1
13	Determination of chloride soil	1
14	Determination of sulphate (SO4--) in ground waters	1
15	Determination of sulphate (SO4--) in soil	1
16	Determination of gypsum requirement of sodic soil	1
17	Determination of lime requirement of acid soil	1

Suggested Readings

Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.

Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.

USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline andAlkali Soils*. Oxford & IBH.

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Bhagwant University, Ajmer (Raj.)

M.Sc. (Ag.) Course Programs

PLANT BREEDING AND GENETICS

	Semester I		
BU Course No.	**Course No**	**Course Title**	**Credit Hours**
01MPBG101	**PBG 511**	Principle of Genetics and cell Biology	**3(2+1)**
01MPBG102	**PBG 512**	Principle of Plant Breeding	**3(2+1)**
01MPBG103	**PBG 513**	Molecular Genetics	**3(3+0)**
01MPBG104	**AGRON 511**	Agrometeorology and crop weather forecasting	**3(2+1)**
	Semester II		
02MPBG101	**PBG 521**	Plant Genetic Resources and Seed Technology	**3(2+1)**
02MPBG102	**PBG 522**	Principle of Quantitative Genetics	**3(2+1)**
02MPBG103	**PBG 523**	Biotechnology for crop improvement	**3(2+1)**
02MPBG104	**PBG 524**	Principle of Cytogenetics	**3(2+1)**
02MPBG105	**STAT 521**	Experimental design	**3(2+1)**
	Semester III		
03MPBG101	**PBG 531**	Mutagenesis and Mutation Breeding	**3(2+1)**
03MPBG102	**PBG 532**	Heterosis Breeding	**3(2+1)**
03MPBG103	**AGRON 521**	Modern concepts in crop production	**3(3+0)**
03MPBG104	**AGRON 522**	Principles and practices of weed management	**3(2+1)**
	Semester IV		
04MPBG101	**PBG 541**	M.Sc. Seminar	**1(0+1)**
04MPBG102	**PBG 542**	Comprehensive	**2(0+2)**
04MPBG103	**PBG 543**	M.Sc. Research	**15**

01MPBG101 Principles of Genetics and Cell Biology 3(2+1)

Objective

This course is aimed at understanding the basic concepts of genetics, and cell biology helping students to develop their analytical, quantitative and problem-solving skills from classical to molecular genetics.

Theory

Principles of Genetics*:*Beginning of genetics; Early concepts of inheritance, Mendel's laws; Discussion onMendel's paper, Chromosomal theory of inheritance.Multiple alleles, Gene interactions. Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes. Crossing over-mechanisms and theories of crossing over- recombination models, cytological basis. Somatic cell genetics, Extra chromosomal inheritance, Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioral genetics.***CellBiology:***Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structureand function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles – nucleus, plastids-chloro/chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes, Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes. Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus- Structure and chemical composition.

Practical

Numericals related to Mendel's laws, gene interaction, linkage and construction of genetic maps. Polygenic inheritance. Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; Principles of microscopy: phase contrast, autoradiography and electron microscopy. Differential centrifugation for isolating macroscopic components. Preparation and use of different killing and fixation reagents used in cytological studies. Preparation of important stains like aceto caramine, aceto orecin and fuelgen stain. Exercises related cell division- mitosis and meiosis.

Lecture schedule: Theory

S. No.	Topic	No. of Lectures
1	Beginning of genetics; Early concepts of inheritance,	1
2	Mendel's laws; and discussion on Mendel's paper,	1
3	Chromosomal theory of inheritance	1
4	Multiple alleles	1
5	Gene interactions. I	1
6	Gene interactions. II	1
7	Sex determination and Differentiation	1
8	Sex-linkage	1
9	Sex linked, Sex-influenced and sex-limited traits	1
10	Detection and Estimation of linkage	1
11	Recombination and genetic mapping in eukaryotes	1
12	Crossing over and its mechanisms	1
13	Theories of crossing over- recombination models	1
14	Cytological basis of crossing over	1
15	Somatic cell genetics	1
16	Extra chromosomal inheritance	1
17	Concepts of Eugenics and Epigenetics	1
18	Genetic disorders and Behavioral genetics	1
19	Cell, its ultrastructures, differences between eukaryotic and prokaryotic cells	1
20	Macromolecules of cell	1
21	Structure and function of cell wall, nuclear membrane and plasma membrane	1
22	Cellular Organelles – nucleus,	1
23	Cellular Organelles – plastids- chloroplasts and chromoplast	1
24	Cellular Organelles- endoplasmic reticulum,	1
25	Cellular Organelles - Golgi complex, lysosomes, peroxisomes.	1
26	Cell Cycle and cell division – mitosis	1
27	Cell division- meiosis, synapsis, structure and function of synaptonemal complex	1
28	Differences, significance and deviations in cell divisions	1
29	Spindle apparatus, anaphase movement of chromosomes.	1
30	Bioenergetics; Ultrastructure and function of mitochondria and biological membranes	1
31	Chloroplast and other photosynthetic organelles	1
32	Interphase nucleus- Structure and chemical composition.	1

Lecture schedule : Practical

S. No.	Topic	No. of lectures
1	Numericals related to Mendel's laws,	1
2	Numericals related to gene interaction	1
3	Laboratory exercises in probability and chi-square	1
4	Numericals related to linkage and construction of genetic maps.	1
5	Chromosome mapping using three point test cross	1
6	Tetrad analysis	1
7	Demonstration of genetic principles using laboratory organisms	1
8	Induction and detection of mutations through genetic tests	1
9	Principles of microscopy: parts of a microscope and their functions, types	1
10	Phase contrast microscopy	1
11	Autoradiography and Electron microscopy.	1
12	Differential centrifugation for isolating macroscopic components	1
13	Preparation and use of different killing and fixation reagents used in cytological studies.	1
14	Preparation of important stains like aceto caramine, aceto orecin and fuelgen stain.	1
15	Exercises related cell division- mitosis	1
16	Exercises related cell division- meiosis.	1

Suggested Readings :

B.D.Singh. 2005. Genetics. Kalyani Publishers, Ludhiana.
Gardner EJ, Simmons, M J and Snustad DP. 1991. Principles of Genetics. John Wiley & Sons Karp G. 2008. Cell and Molecular Biology: Concepts and Experiments. John Wiley and Sons. Klug WS & Cummings MR. 2003. Concepts of Genetics. Peterson Edu. Lewin B. 2008. Genes IX. Jones & Bartlett Publ.
P.K.Gupta. 2006. Cell Biology, Rastogi Publications.
Russell PJ. 1998. Genetics. The Benzamin/Cummings Publ. Co.
Snustad DP & Simmons MJ. 2006. Genetics. 4th Ed. John Wiley & Sons. Strickberger MW. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs.
Uppal S, Yadav R, Subhadra & Saharan RP. 2005. Practical Manual on Basic and Applied Genetics. Dept. of Genetics, CCS HAU Hisar.

01MPBG102 Principles of Plant Breeding 3(2+1)

Objective

To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

Theory:

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance, genetic basis of breeding self- and cross -pollinated crops including mating systems and response to selection - nature of variability, components of variation; Heritability and genetic advance, genotype-environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and roleof plant genetic resources in plant breeding, pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach), breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and interpopulation improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds, breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection, self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding, special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses.

Practical:

Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops.

Lecture schedule: Theory

S. No.	Topic	No. of lectures
1	Introduction and History of Plant Breeding (Pre and post-Mendelian era)	1
2	Objectives of plant breeding, characteristics improved by plant breeding	1
3	Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.	1
4	Genetic basis of breeding self- and cross -pollinated crops	1
5	Mating systems and response to selection	1
6	Nature of variability, components of variation, heritability and genetic advance	1
7	Genotype-environment interaction	1
8	Combining ability: Introduction and types (General and specific combining ability,	1
9	Types of gene actions and implications in plant breeding	1
10	Plant introduction and role of plant genetic resources in plant breeding.	1
11	Breeding methods in self-pollinated crops, Pure line theory & Pure line selection	1
12	Mass selection methods	1
13	Line breeding Method, Pedigree Method	1
14	Bulk Method and Single seed descent Method	1
15	Backcross Method	1
16	Multiline method	1
17	Population breeding in self-pollinated crops (diallel selective mating approach)	1
18	Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods	1
19	S1 and S2 progeny testing, progeny selection schemes	1
20	Recurrent selection schemes for intra and inter- population improvement I	1
21	Recurrent selection schemes for intra and inter- population improvement II	1
22	Development of synthetics and composites	1
23	Hybrid breeding - genetical and physiological basis of heterosis and inbreeding	1
24	Production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance	1
25	Seed production of hybrid and their parent varieties/inbreds.	1
26	Breeding methods in asexually/clonally propagated crops, clonal selection and apomixes,	1
27	Male sterility in crop plants and their commercial exploitation	1
28	Self-incompatibility in crop plants and their commercial exploitation	1
29	Concept of plant ideotype and its role in crop improvement	1
30	Transgressive breeding	1
31	Mutation breeding	1
32	Breeding for abiotic and biotic stresses	1

Lecture schedule: Practical

S. No.	Topic	No. of lectures
1	Floral biology of important crops of the locality. I	1
2	Floral biology of important crops of the locality. II	1
3	Emasculation, selfing and crossing techniques.	1
4	Floral biology in self-pollinated species I	1
5	Floral biology in self-pollinated species II	1
6	Floral biology in cross pollinated species I	1
7	Floral biology in cross pollinated species II	1
8	Selection methods in segregating populations and evaluation of breeding material	1
9	Observation recording	1
10	Analysis of variance (ANOVA) through RBD	1
11	Analysis of variance (ANOVA) through LSD	1
12	Estimation of components of variance, heritability and genetic advance	1
13	Maintenance of experimental records	1
14	Learning techniques in hybrid seed production using male-sterility in field crops (pearl millet)	1
15	Learning techniques in hybrid seed production using male-sterility in field crops (sorghum)	1
16	Learning techniques in hybrid seed production using male-sterility in field crops (Maize)	1

Suggested Readings:

Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
Chopra VL. 2001. Breeding Field Crops. Oxford & IBH.
Chopra VL. 2004. Plant Breeding. Oxford & IBH.
Gupta SK. 2005. Practical Plant Breeding. Agribios. Jodhpur
Pohlman JM & Bothakur DN. 1972. Breeding Asian Field Crops. Oxford & IBH.
Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill. Simmonds NW. 1990. Principles of Crop Improvement. English Language Book Society.
Dana, Sukumar. 2001. Plant Breeding. Naya Udyog, Colcutta. 700 006
Kucku, Kobabe and Wenzel (1995). Fundamentals of Plant Breeding. Narosa Publishing House, Delhi
Singh BD. 2006. Plant Breeding. Kalyani.
Singh P. 2002. Objective Genetics and Plant Breeding. Kalyani.
Singh P. 2006. Essentials of Plant Breeding. Kalyani.

01MPBG103 Molecular Genetics 3(3+0)

Objective

To impart knowledge in theory of structure and function of genetic material and major macromolecules of the cell.

Theory:

Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, Genetic code, DNA transcription and its regulation – Transcription factors and their role; regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors, mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; Gene amplification and its significance; Proteomics and protein-protein interaction, split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters, regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Molecular chaperones and gene expression. Gene regulation in eukaryotes, RNA editing, genomics and proteomics; Functional and pharmacogenomics; Metagenomics. Signal transduction; Genes in development; Cancer and cell aging, methods of studying polymorphism at biochemical and DNA level;

Lecture schedule: Theory

S. No.	Topic	No. of lectures
1	Historical Background of Molecular Genetics	1
2	Genetic material and properties of nucleic acid	2
3	Genetic code	1
4	Transcription and its regulation	1
5	Transcriptional factors	1
6	Protein synthesis and its regulation in pro and eukaryotes	1
7	t RNAs and translational factors	1
8	Mechanism of recombination	1
9	DNA organization in eukaryotic chromosomes	1
10	Unique and repetitive sequences : its discovery and types	1
11	Gene amplification, mechanism of gene duplication, significance	1
12	Split genes, overlapping genes and pseudogenes	1
13	Oncogenes. Gene families and clusters	1
14	Proteomics : definition and protein -protein interactions	1
15	Transposable elements: discovery, characteristics in prokaryotes	2
16	Transposable elements : eukaryotic. Genetic consequences of transposition.	1
17	Gene regulation in prokaryotes: positive, negative and attenuation	2
18	Gene regulation in eukaryotes	2
19	Molecular mechanism of mutation: tuatomerism, types of mutation	1
20	Suppressor mutation and repair, NER/BER, SOS	2
21	Molecular chaperones and RNA editing	1
22	Genomics : definition, genome projects, structural and functional genomics	1
23	Pharmacogenomics and Metagenomics	1
24	Signal transduction : Rhizobium nodulation case study.	1
25	Genes in development, cancer and cell againg	1
26	Methods of studying polymorphism at molecular level: isozyme pattern, RFLP,RAPDs , AFLPs and SNPs.	3

Suggested Readings

Bruce A.2004. *Essential Cell Biology*.

Friefelder, D. 1990. Molecular genetics. Narosa Publishing house, New Delhi.

Karp G.2011 .*Cell and Molecular Biology: Concepts and Experiments*. 6th Edn. John Wiley.

Klug WS & Cummings MR 2003. *Concepts of Genetics*. Scot, Foreman & Co.

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

Lodish H, Berk A & Zipursky SL. 2004. *Molecular Cell Biology*. 5th Ed.

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

Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley Publ. Co.WH Freeman & Co.

WH Freeman. Nelson DL & Cox MM. 2005. *Lehninger'sPrinciples of Biochemistry*.

Winter, P C., Hickey, G I., and Fletcher, H L. 1999. Instant Notes in Genetics. Viva Book Pvt. Ltd. New Delhi.

01MPBG104 Agrometeorology and Crop Weather Forecasting 3(2+1)

Objective

To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

Theory:

Agro meteorology: aim, scope and development in relation to crop environment, composition of atmosphere,distribution of atmospheric pressure, Solar radiation : characteristics, energy balance of atmosphere system, radiation distribution in plant canopies, radiation utilization by field crops, photosynthesis and efficiency of radiation utilization by crops, energy budget of plant canopies, Environmental temperature: soil, air, canopy temperature, temperature profile in air, soil and crop canopies, soil and air temperature effects on plant processes, regulation of air, soil temperature for protection against frost and hot winds, Environmental moisture and evaporation, measures of atmospheric moisture, temperature, relative humidity, vapour pressure and their relationship, evapotranspiration and meteorological factors determining evapotranspiration, Modification of plant environment: artificial rain making, controlling heat load, heat trapping and shedding, protection from cold, reduction in sensible and latent heat flux, Monsoon: monsoon and their origin, characteristics of monsoon, onset and progress of monsoon, withdrawal of monsoon, Weather forecasting in India: short, medium and long range forecasting, benefits of weather service to agriculture, forecasting of destructive frost, soil moisture forecast, phenological forecast, crop yield forecast, Aero-space science and remote sensing : application in agriculture, present status of remote sensing in India, Atmospheric pollution and its effect on climate and crop production.

Practical

Agrometeorological observatory- classes, site selection, layout and installation of meteorological instruments; handling of meteorological instruments; measurement of weather parameters; working out agroclimatic indices; maintenances of record; calculation of daily, weekly and monthly means; visit to state remote sensing centre, Jodhpur/Jaipur; measurement of soil temperature in different soil conditions/depths; interpretation and use of weather data; rainfall analysis for variability; moisture availability indices for an arid and a humid district, length of growing season, fitting cropping systems; preparation of weathe r maps, synoptic charts and weather reports; preparation of crop weather calendars, to become familiar with agro advisory service bulletins visit to ARS, Durgapura/Bikaner.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Agro meteorology - aim, scope and development in relation to crop environment	2
2	Composition of atmosphere, distribution of atm. pressure	1
3	Solar radiation - characteristics	1
4	Energy balance of atmosphere system	1
5	Radiation distribution in plant canopies, radiation utilization by field crops	2
6	Photosynthesis and efficiency of radiation utilization by crops	2
7	Energy budget of plant canopies	1
8	Environmental temperature- soil, air, canopy temperature, temperature profile in air, soil, crop canopies	2
9	soil and air temperature effects on plant processes	2
10	Regulation of air, soil temperature for protection against frost and hot winds	2
11	Environmental moisture and evaporation - measures of atmospheric moisture, temperature, relative humidity, vapour pressure and their relationship	2
12	Evapotranspiration and meteorological factors determining evapotranspiration	2
13	Modification of plant environment, artificial rain making, controlling heat load, heat trapping and shedding	2
14	Protection from cold, reduction in sensible and latent heat flux	1
15	Monsoon and their origin, characteristics of monsoon	1
16	Onset and progress of monsoon withdrawal of monsoon	1
17	Weather forecasting in India: short, medium and long range forecasting	2
18	Benefits of weather service to agriculture, forecasting of destructive frost, soil moisture forecast, phenological forecast, crop yield forecast etc	2
19	Aero-space science and remote sensing - application in agriculture, present status of remote sensing in India.	2
20	Atmospheric pollution and its effect on climate and crop production	1

Lecture schedule- Practical

S. No.	Topic	No. of lectures
1	Agro meteorological observatory – classes, site selection, layout and installation procedures for meteorological instruments	1
2	Handling of meteorological instruments	1
3	Measurement of weather parameters	1
4	Working out agro climatic indices	1
5	Maintenance of records	1
6	Calculation of daily, weekly and monthly means	2
7	Visit to state Remote Sensing Centre, Jodhpur/Jaipur	1
8	Measurement of soil temperature in different soil conditions/depths	1
9	Interpretation and use of weather data	1
10	Rainfall analysis for variability	2
11	Moisture availability indices for an arid district	1
12	Moisture availability indices for a humid district	1
13	Length for growing season, fitting cropping systems	1
14	Preparation of weather maps, synoptic charts & weather reports	1
15	Preparation of crop weather calendar	1
16	To become familiar with Agro-advisory-service bulletins/	1

Suggested Readings:

S. Mavi (1994). Introduction to Agrometeorology. Oxford & IBH Publishing Co.New Delhi.

P.A. Menon (1989). Our weather. National Book Trust, New Delhi.

A.B. Rama Sastu (1984). Weather and Weather forecasting Publication Division, GOI. P.K.

Das (1992). The Monsoon. National Book Trust, New Delhi.

S. Venkateraman and A. Krishnan. Crops and Weather. Indian Council of Agricultural Research, New Delhi.

Critchfield, H.J. 1995. General Climatology, Prentice Hall of India Pvt. Ltd., New Delhi

R.S. Gena and S.P. Seetharaman (1991). Natural Resource Management: The Role of Remote sensing in decision making. Oxford & IBH Publishing Co. New Delhi.

K.L. Joshi, Sinha and D.P. Gupta (1985). Physical Geography, National Council of Educational Research and Training, New Delhi.

Vasiraju Radha Krishna Murthy (1995). Practical Manual on Agricultural Meteorology, Kalyani Publishers, Ludhiana.

D.S. Lal, 1998. Climatology. Sharda Pustak Bhawan.

S.R. Ghadekar, 1991. Meteorology, Agromet Publishers, Nagpur.

A.K. Sacheti, 1985. Agricultural Meteorology- Instructional-cum-Practical Manual. NCERT, New Delhi. Mavi H.S. and Tuper G.J. 2004. Agrometeorology: Principles and Application of Climate Studies inAgriculture. Haworth Press.

Vashneya M.C. and Balakrishana Pillai P. 2003. Textbook of Agricultural Meteorology, ICAR.

02MPBG101 Plant genetic resources & seed technology 3(2+1)

Theory:

Genetic resources in historical perspectives, gene pool, centres of origin and diversity. Types of genetic resources and their survey- objectives, limitations, priorities and techniques. Germplasm introduction and exchange. Principles of *invitro* and cryopreservation. Germplasm conservation *in-situ*, *ex situ* and on farm, short, medium, long termconservation strategies for orthodox and non-orthodox seed, vegetatively propagated cops. Rajasthan of plant genetic resources, PGR data base management, descriptors. Regional, national and international mechanism for PGR management. Plant genetic resources for food and agriculture. PGR access and benefit sharing; IPR, PBR, UPOV & CBD issues; farmers' rights & privilege, History of seed industry and role of various seed organizations. Seeds act and seed rules and law enforcement. Seed control order. New seed act seed policy. Variety: definition, types, development, release system and notification. Objectives and principles of seed production. Factors affecting seed production, variety maintenance, nucleus and breeder seed production in different crop groups. Production of certified and foundation seed in different crop plants *viz*; cereals, oilseeds, pulses, fibre and forage crops. Concept, purpose and phases of seed certification, seed certification agency. Variety eligibility, class and sources of seed, field inspection and minimum seed and field certification standards. DUS test and VCU. Variety identification through biochemical procedures.

Practical:

Seed testing methods and seed dormancy. Seed production planning in different crops with special reference to land and isolation requirements. Roguing, harvesting and threshing. Character of important varieties and its maintenance. Field inspection at different crop growth stages off types, pollen shedders, seed borne diseases. Visit to seed production plots. Visit to gene bank.

Lecture schedule: Theory

S.No.	Topic	No. of lectures
1	Genetic resources in historical perspectives	1
2	Gene pool, centers of origin and diversity	1
3	Types of genetic resources	1
4	Genetic resources and their survey	1
5	Germplasm introduction and exchange	1
6	Principles of *in vitro* and cryopreservation	1
	Germplasm conservation: i. Types and material conserved	1
8	ii. Conservation strategies	1
9	iii. Seed Gene Bank	1
10	Registration of plant genetic resources	1
11	Regional & National activities for PGR management	1
12	International activities for PGR management	1
13	Plant genetic resources for food and agriculture	1
14	PGR access resources and benefit sharing	1
15	IPR, PBR, UPOV & issues, farmers right etc.	1
16	History of seed industry	1
17	Role of various seed organizations	1
18	Seeds Act and Seed Rules	1
19	Law enforcement and powers of seed inspectors	1
20	New seed act, inspection procedure	1
21	Variety development, evaluation, release and notification	1
22	Objectives and principles of seed production	1
	Factors affecting seed production and variety maintenance	1
24	Production and maintenance of nucleus and breeder seed in different crop groups (Varieties)	1
25	Production and maintenance of nucleus and breeder seed in different crop groups (Hybrids)	1
	Production of foundation and certified seed in cereals crops	1
	Production of foundation and certified seed in oilseeds crops	1
	Production of foundation and certified seed in pulses and forage crops	1
29	Seed certification- concept, purpose, phases and certification agencies.	1
30	Variety eligibility, classes and sources of seed etc.	1
31	Field inspection and minimum seed and field standards for certification	1
32	DUS test, VCU and variety identification.	1

Lectue schedule : Practical

S.No.	Topic	No. of lectures
1	Seed testing : i. Viability	1
2	ii. Health	1
3	iii. Moisture	1
4	iv. Purity	1
5	Seed dormancy	1
6	Seed production planning in cereal crops (Nucleus, breeder, foundation, certified)	1
7	Seed production planning in pulses crops (Nucleus, breeder, foundation, certified)	1
8	Seed production planning in oil seed crops (Nucleus, breeder, foundation, certified)	1
9	Seed production planning in millet crops (Nucleus, breeder, foundation, certified)	1
10	Seed production planning in forage crops (Nucleus, breeder, foundation, certified)	1
11	Characters of important cereals and millets crop varieties and their maintenance	1
12	Characters of important oilseed, pulses and forages crop varieties and their maintenance	1
13	Field inspection at different growth stages	1
14	Pollen shedders and seed borne diseases	1
15	Visit to seed production plots	1
16	Visit to gene bank	1

Suggested Readings:

Dhirendra Khare and Mohan S. Bhale, 2000. Seed Technology. Scientific Publishers, P.O. Box 91, Jodhpur.

F.L. Brian and M. Jackson, 1986. Plant Genetics Resources- An introduction to their conservation and use. Edward Annold, London.

Gautam, P.L., Dabas, B.S., Srivastava, V and Duhoon, D.S. (Eds.), 1988. Plant Germplasm Collecting Principles and Procedures. NBPGR Publication, NBPGR, New Delhi.

J.H.W. Holden and J.T. Williams, 1984. Crop Genetic Resources, Conservation and Evaluation. Oxford Books and Stationary Co., Delhi.

N. Ghosh and Subirsen, 1999. Seed Science and Technology. Kalyani Publishers, Ludhiana.

Paroda, R.S., Arora, R.K. and Chandel, K.P.S. (Eds.), 1988. Plant Genetic Resources. Indian Perspective. NBPGR, New Delhi.

R.L. Agrawal, 1996. Seed Technology. IBH Publishing C0., New Delhi.

Tomar, H.S., 2003. Seed Technology. Aman Publishing House, Meerut (U.P.)

02MPBG102 Principles of Quantitative Genetics 3(2+1)

Objective

To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects.

Theory

Population -Mendelian population – Random mating population -Frequencies of genes and genotypes-Causes of change: Hardy- Weinberg equilibrium, Mendelian traits *vs* polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects, principles of Anaylis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance, designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D^2 analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance, generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis – principles and interpretation.

Practical:

Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis -Metroglyph analysis - D^2 analysis - Grouping of clusters and interpretation - Cluster analysis - Construction of cluster diagrams and dendrograms - interpretation - Correlation analysis - Path analysis - Parent-progeny regression analysis - Diallel analysis: Griffing's methods I and II - Diallel analysis: Hayman's graphical approach - Diallel analysis: interpretation of results - NCD and their interpretations - Line x tester analysis andinterpretation of results -Estimation of heterosis : standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression -Generation mean analysis: Analytical part and Interpretation -Estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions - Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies - Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross (TTC) – use of softwares in analysis and result interpretation, Advanced biometricalmodels for combining ability 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.

Lecture schedule: Theory

S. No.	Topic	No. of lectures
1	Population: Mendelian population, Random mating population, Frequencies of genes and genotypes.	1
2	Causes of change: Hardy- Weinberg equilibrium.	1
3	Mendelian traits *vs* polygenic traits, nature of quantitative traits and its inheritance, Multiple factor hypothesis, analysis of continuous variation.	1
4	Concept of genotypic, phenotypic and breeding value. Population mean, additive and dominance variance etc.	1
5	Variations associated with polygenic traits - phenotypic, genotypic and environmental & non- allelic interactions.	1
6	Nature of gene action - additive, dominance, epistatic and linkage effects.	1
7	Principles of Analysis of Variance (ANOVA), Expected variance components, random and fixed models.	1
8	MANOVA, biplot analysis.	1
9	Comparison of means and variances for significance.	1
10	Designs for plant breeding experiments – principles and applications.	1
11	Commonly used designs: RBD and CRD.	1
12	LSD and Augmented Design.	1
13	Genetic diversity: Metroglyph analysis.	1
14	Cluster and D^2 analyses.	1
15	Association analysis – phenotypic, genotypic covariances & correlations.	1
16	Regression analysis including parent-progeny regression.	1
17	Path analysis.	1
18	Discriminant function analysis.	1

19	Principal component analyses	1
20	Concepts of selection, Selection indices & selection of parents.	1
21	Simultaneous selection models.	1
22	Heritability and genetic advance.	1
23	Generation mean analysis.	1
24	Concepts of combining ability and gene action. Introduction to mating designs.	1
25	Diallel analysis: Hayman's approach	1
26	Diallel analysis: Griffing's approach	1
27	Partial diallel and line x tester analysis	1
28	Biparental mating (NCDs)	1
29	Triple Test Cross etc..	1
30	Analysis of genotype x environment interaction - adaptability and stability.	1
31	Models for G x E analysis and stability parameters.	1
32	AMMI analysis – principles and interpretation.	1

Lecture schedule :Practical

S.No.	Topic	No. of lectures
1	Problems on multiple factors inheritance, Partitioning of variance, Estimation of heritability and genetic advance.	1
2	Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions	1
3	Covariance analysis. Correlation and regression analysis. Parent-progeny regression analysis	1
4	Metroglyph analysis - D^2 analysis - Grouping of clusters and interpretation - Cluster	1
	analysis - Construction of cluster diagrams and dendrograms - interpretation	
5	Diallel analysis: Hayman's graphical approach, interpretation of results.	1
6	Diallel analysis: Griffing's methods I and II, interpretation of results.	1
7	North Carolina Designs and their interpretations.	1
8	Line x tester analysis and interpretation of results.	1
9	Estimation of heterosis : standard, mid-parental and better-parental heterosis –Estimation of inbreeding depression	1
10	Generation mean analysis: Analytical part and Interpretation -Estimation of different types of gene actions.	1
11	Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping;	1
12	Working out efficiency of selection methods in different populations and interpretation.	1
13	Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross (TTC): use of softwares in analysis and result interpretation.	1
14	Advanced biometrical models for combining ability analysis	1
15	Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model -Principal Component Analysis model - Additive and multiplicative model - Shifted multiplicative model	1
16	Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems -Biplots and mapping genotypes.	1

Suggested Readings

Bos I & Caligari P. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall. Falconer DS & Mackay J. 1998. *Introduction to Quantitative Genetics*. Longman. Mather K & Jinks JL. 1971. *Biometrical Genetics*. Chapman &Hall. Mather K & Jinks JL. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall. Naryanan SS & Singh P. 2007. *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. WeirDS. 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.

02MPBG103 Biotechnology for Crop Improvement 3(2+1)

Objective

To impart knowledge and practical skills to use biotechnological tools in crop improvement.

Theory

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding. Tissue culture-History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation. Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR-based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs). Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH). Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis,Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Marker-assisted backcross breeding for rapid introgression, Generation of EDVs. Gene pyramiding. Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.Biotechnology applications in male sterility/hybrid breeding, molecular farming. Gene silencing.MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights . Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.

Practical

Requirements for plant tissue culture laboratory-Techniques in plant tissue culture - Media components and media preparation -Aseptic manipulation of various explants ; observations on the contaminants occurring in media – interpretations - Inoculation of explants; Callus induction and plant regeneration -Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening proceduresVisit to commercial micropropagation UNIT. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

Lecture schedule: Theory

S. No.	Topic	No. of lectures
1	Biotechnology and its relevance in agriculture; definitions, terminologies and scope in plant breeding.	2
2	Tissue culture- History, callus, suspension cultures, cloning.	2
3	Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques.	1
4	Ovary and embryo culture; cryopreservation.	1
5	Genotyping; Sequencing techniques	2
6	Vectors, vector preparation and cloning	1
7	Recombinant DNA technology, transgenes, method of transformation	2
8	Selectable markers and clean transformation techniques,	1
9	vector-mediated gene transfer, physical methods of gene transfer	1
10	Production of transgenic plants in various field crops: cotton, wheat, maize	2
11	Rice, soybean, oilseeds, sugarcane etc. Commercial releases	2
12	Biotechnology applications in male sterility/hybrid breeding, molecular farming.	1
13	Biochemical and molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.)	2
14	Mapping populations (F2s, back crosses, RILs, NILs and DH).	1
15	Molecular mapping and tagging of agronomically important traits	2
16	Statistical tools in marker analysis, Robotics, QTLs analysis in crop plants	2
17	Marker-assisted selection for qualitative and quantitative traits, Gene pyramiding.	1
18	Marker assisted selection and molecular breeding	1
19	Genomics for crop improvement	1
20	Integrating functional genomics information on agronomically/economically important traits in plant breeding;	2
21	Marker-assisted backcross breeding for rapid introgression, Generation of EDVs	2
22	MOs and related issues (risk and regulations);	1
23	GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in India, ethical, legal and social issues;	2
24	Intellectual property rights	1
25	Introduction to Bioinformatics & Bioinformatics tools	1
26	Introduction to Nanotechnology and its applications in crop improvement programmes.	1

Lecture schedule :Practical

S. No.	Topic	No. of lectures
1	Requirements of a tissue culture laboratory, tissue culture techniques, media preparation	1
2	Sterilizttion techniques	1
3	Inoculation techniques	1
4	Callus induction and plant regeneration	1
5	Regeneration protocols	1
6	Green house and hardening procedures	1
7	Visit to commercial micropropagation units	1
8	Transformation using Agrobacterium strains	1
9	Gus assay in transformed cells/tissues	1
10	DNA isolation	1
11	DNA agarose gel electrophoresis , DNA purity and quantization	1
12	Gel Electrophoresis of proteins and isozymes	1
13	DNA amplification using PCR	1
14	Assessing RAPD marker	1
15	Gel scoring and data analysis and tagging phylogenetic relationship	1
16	Construction of genetic linkage map using computer software	1

Suggested Readings

Chawala H.S. 2000. Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd.

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.

Gupta PK. 1997. *Elements of Biotechnology.* Rastogi Publ.

02MPBG104 Principles of Cytogenetics 3(2+1)

Objective

To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.

Theory:

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes. Variation in chromosome structure: Evolutionary significance -Introduction to techniques for karyotyping; Chromosome banding and painting -in situ hybridization and various applications. Structural and Numerical variations of chromosomes and their implications - Symbols and terminologies for chromosome numbers - euploidy -haploids, diploids and polyploids ; Utilization of aneuploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes. Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids –- Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis - Evolutionary and genetic problems in crops with apomixes.

Reversion of autopolyploids to diploids; Genome mapping in polyploids - Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) – Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids - Bridge species.

Fertilization barriers in crop plants at pre-and postfertilization levels- In vitro techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization ; case studies – Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical:

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. - Microscopy: various types of microscopes, Preparing specimen for observation -Fixative preparation and fixing specimen for light microscopy studies in cereals -Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion. Studies on the course of meiosis - Using micrometers and studying the pollen grain size in various crops - Pollen germination and in vitro; Demonstration of polyploidy.

Lecture schedule: Theory

S. No.	Topic	No. of lectures
1	Architecture of chromosome in prokaryotes: Nucleiod etc.	1
2	Architecture of chromosome in eukaryotes: Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere	1
3	Artificial chromosome construction and its uses	1
4	Special types of chromosomes.	1
5	Introduction to techniques for karyotyping;	1
6	Chromosome banding and painting	1
7	In situ hybridization and various applications.	1
8	Variation in chromosome structure: Evolutionary significance	1
9	Numerical variations of chromosomes and their implications - Symbols and terminologies for chromosome numbers	1
10	Euploidy –haploids, diploids and polyploids	1
11	Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids	1
12	Utilization of aneuploids in gene location	1
13	Variation in chromosome behaviour - somatic segregation and chimeras	1
14	Endomitosis and somatic reduction	1
15	Evolutionary significance of chromosomal aberrations	1
16	Balanced lethals and chromosome complexes	1
17	Balanced lethals and chromosome complexes	1
18	Inter-varietal chromosome substitutions	1
19	Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer	1
20	Alien addition and substitution lines – creation and utilization	1
21	Apomixis - Evolutionary and genetic problems in crops with apomixes.	1
22	Reversion of autopolyploids to diploids	1
23	Genome mapping in polyploids	1
24	Interspecific hybridization and allopolyploids	1

25	Synthesis of new crops (wheat, triticale and brassica)	1
26	Hybrids between species with same chromosome number	1
27	Hybrids between species with different chromosome number, alien translocations	1
28	Gene transfer using amphidiploids - Bridge species.	1
29	Fertilization barriers in crop plants at pre-and postfertilization levels	1
30	In vitro techniques to overcome the fertilization barriers in crops	1
31	Chromosome manipulations in wide hybridization	1
32	Case studies – Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.	1

Lecture schedule : Practical

S. No.	Topic	No. of lectures
1	Learning the cytogenetics laboratory	1
2	Various equipments used in cytogenetics laboratory	1
3	Various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc.	1
4	Microscopy: Introduction and parts.	1
5	Various types of microscopes	1
6	Preparing specimen for observation	1
7	Fixative preparation and fixing specimen for light microscopy studies in cereals	1
8	Studies on the course of mitosis in wheat	1
9	Studies on the course of mitosis in pearl millet	1
10	Studies on the course of mitosis in onion	1
11	Studies on the course of meiosis	1
12	Studies on the course of meiosis	1
13	Using micrometers and studying the pollen grain size in various crops 1	1
14	Using micrometers and studying the pollen grain size in various crops 2	1
15	Pollen germination	1
16	Demonstration of polyploidy.	1

Suggested Readings

B.D.Singh. 2005. Genetics. Kalyani Publishers
Becker K & Hardin. 2004. The World of Cell. 5th Ed. Pearson Edu.
CarrollM.1989.Organelles.The Guilford Press.
CharlesB.1993. Discussions in Cytogenetics.Prentice Hall.
Darlington CD & La Cour LF. 1969. The Handling of Chromosomes.
Gray P. 1954. The Mirotomist's Formulatory Guide. The Blakiston Co.

02MPBG107 Experimental Designs 3(2+1)

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. 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

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control, Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design, Factorial experiments, (symmetrical as well as asymmetrical), orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment, 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, resolvable designs and their applications ~ concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

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; Analysis of resolvable designs; Fitting of response surfaces.

Lecture schedule: Theory

S. No.	Topics	No. of Lectures
1.	Basic concepts of design of experiment	2
	Basic principles of designs	3
3.	Uniformity trials	1
4.	Size and shape of plots and blocks	1
5.	Analysis of variance and transformations	2
6.	CRD, RBD and LSD	3
7.	Factorial experiments	4
8.	Confounding in symmetrical factorial experiments	2
9.	Factorial experiments with control treatment	2
10.	Split plot design	2
11.	Strip plot design	2
12.	Analysis of covariance and missing plot techniques	2
13.	crossover designs	1
14.	resolvable designs	1
15.	Response surfaces	2
16.	Experiments with mixtures	2

Lecture schedule: Practical

S. N.	Topics	No. of Lectures
1.	Formation of plots	1
2.	Formation of blocks	1
3.	Analysis of CRD	1
4.	Analysis of RBD	1
5.	Analysis of LSD	1
6.	Analysis of factorial experiment	1
7.	Analysis of asymmetric factorial experiments	1
8.	Analysis of confounded factorial experiments	1
9.	Analysis with missing data in RBD	1
10.	Analysis with missing data in LSD	1
11.	Transformation of data	1
12.	Analysis of SPD	1
13.	Analysis of strip plot design	1
14.	Analysis of resolvable designs	1
15.	Fitting of response surfaces	2

References:

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 Publ.

03MPBG101 Mutagenesis and Mutation Breeding 3(2+1)

Objective

To impart the knowledge about general principles of radiation and various tests/methods for detection of radiation effects on the living cells, genetic risks involved and perspectives of advances made.

Theory

Mutation and its history - Nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations -Detection of mutations in lower and higher organisms – paramutations. Mutagenic agents: physical -- Radiation types and sources: Ionising and non-ionizing radiations *viz.*, X rays, γ rays, , α and β particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations (, photoelectric absorption, Compton scattering and pair production) and their biological effects –RBE and LET relationships.Effect of mutations on DNA - Repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects Dosimetry -Objects and methods of treatment - Factors influencing mutation: dose rate, acute *vs* chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects - Radiation sensitivity and modifying factors: External and internal sources- Oxygen, water content, temperature and nuclear volume. Chemical mutagens- Classification - Base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action - Dose determination and factors influencing chemical mutagenesis Treatment methods using physical and chemical mutagens - Combination treatments; Other causes of mutation -direct and indirect action, comparative evaluation of physical and chemical mutagens. Observing mutagen effects in M1 generation: plant injury, lethality, sterility, chimeras *etc.*, - Observing mutagen effects in M2 generation -Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations –- Mutations in traits with continuous variation. Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage *etc*. - Individual plant based mutation analysis and working out effectiveness and efficiency in M3 generation -Comparative evaluation of physical and chemical mutagens for creation of variability in the same species – Case studies. Use of mutagens in creating oligogenic and polygenic variations – Case studies -*In vitro* mutagenesis – callus and pollen irradiation; Handling of segregating genrations and selection procedures; Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement,etc) in different crops- Procedures for micro-mutations breeding/polygenic mutations- Achievements of mutation breeding-varieties released across the world- Problems associated with mutation breeding. Use of mutagens in genomics, allele mining, TILLING.

Practical

Learning the precautions on handling of mutagens; Dosimetry - Studies of different mutagenic agents: Physical mutagens - Studies of different mutagenic agents: Chemical mutagens - Learning on Radioactivity – Production of source and isotopes at BRIT, Trombay - Learning about gamma chamber; Radiation hazards - Monitoring – safety regulations and safe transportation of radioisotopes -Visit to radio isotope laboratory ; learning on safe disposal of radioisotopes - Hazards due to chemical mutagens - Treating the plant propagules at different doses of physical and chemical mutagens - Learning combined mutagenic treatments; Raising the crop for observation - Mutagenic effectiveness and efficiency; Calculating the same from earlier literature - Study of M1 generation – Parameters to be observed; Study of M2 generation – Parameters to be observed; Procedure for detection of mutations for polygenic traits in M2 and M3 generations.

Lecture schedule: Theory

SN	Topic	No.of lectures
1	Historical perspectives and definition of mutation	1
2	Different ways of classification of mutations	2
3	Mutation detections systems, paramutation	1
4	Mutagenic agents : Physical; different particulate & aparticulate radiations	1
5	Mode of action of gamma rays, photoelectric effect, Compton scattering and ion pair production and their effects on biological system	1
6	Repair mechanisms, mutation rate, frequency, dosimetry	2
7	Internal and external factors affecting influencing muttions	1
8	Chemical mutagens, classification, types and mode of actions	2
9	Combination treatments and comparisons	1
10	Treatment procedures and factors to be considered	2
11	Mutagen specificity	2
12	Observing mutagen effects, criteria of biological damage , quantification of damage using germination, chromosomal aberration and gametic sterility, and estimating spectrum of mutation	2
13	estimation of mutagenic effectiveness and efficiency using biological damage and spectrum of mutations observed in M1 & M2 populations	2
14	Factors influencing mutation spectrum: genotype, pleiotropy, linkage, type of mutagen. Case studies	2
15	Use of mutagens for creating oligo and polygenic mutations, rationale for using mutation breeding, selection sieves, size of mutated populations to be handled,	2
16	Handling of M1 , M2 and subsequent generations for identification of mutants..	2
17	Mutations breeding for various traits	1
18	Achievements of mutation breeding	2
19	Use of mutations in genomics, allele mining	2
20	TILLING	1

Lecture schedule : Practical

S.No.	Topic	No. of
1	Learning precautions on handling of mutagenic agents	1
2	Physical mutagens: dosimetry	2
3	Radioactivity: production of source and isotopes at BRIT, Trombay	1
4	Learning about gamma chamber, radiation hazards, monitoring, safety egulations, and safe transportation of radioisotopes.	2
5	Visit to radioisotope laboratory	1
6	Treating plant propagules (seeds) with graded dose different chemical mutagens, Computing LD50 for different cops of interest	4
7	Estimating biological damage	2
8	Learning combined mutagenic effect, raising the crop for estimatingthe mutagenic of efficiency and effectiveness using data from the literature.	2
9	Studying M1 and M2 parameters	1

Suggested Readings

Alper T. 1979. *Cellular Radiobiology*. Cambridge Univ. Press, London.

Chadwick KH & Leenhouts HP. 1981. *The Molecular Theory of Radiation Biology*. Springer-Verlag. Cotton RGH, Edkin E & Forrest S. 2000. *Mutation Detection: A Practical Approach*. Oxford Univ. Press. International Atomic Energey Agency. 1970. *Manual on Mutation Breeding*. International Atomic Energey Agency, Vienna, Italy.

Singh BD. 2007. *Genetics*. Kalyani.

03MPBG102 Heterosis Breeding 3(2+1)

Objective

To provide understanding about mechanisms of heterosis and its exploitation for yield improvement through conventional and biotechnological approaches.

Theory

Historical aspect of heterosis - Nomenclature and definitions of heterosis - Heterosis in natural population and inbred population; Evolutionary aspects -Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops. Pre Mendelian and Post-Mendelian ideas -Genetic theories of heterosis –Physiological, Biochemical and molecular actors underlining heterosis; theories and their estimation; - Evolutionary concepts of heterosis. rediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies. - Relationship between genetic distance and expression of heterosis – case studies; Divergence and Genetic Distance analyses-morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis. Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of self-incompatibility in development of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids. Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops; Male sterile line creation and diversification in self-pollinated, cross pollinated and asexually propagated crops; problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid. Organellar heterosis and complementation - Creation of male sterility through genetic engineering and its exploitation in heterosis. Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

Practical

Selection indices and selection differential – Calculations and interpretations - Male sterile line characterization in millets; Using morphological descriptors; Restorer line identification and diversification of male sterile sources - Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; Ways of overcoming them - Male sterile line creation, diversification and restoration in forage crops; Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops -Estimation from the various models for heterosis parameters -Hybrid seed production in field crops – an account on the released hybrids; their potential; Problems and ways of overcoming it; hybrid breeding at National and International level; Opportunities ahead.

Lecture schedule: Theory

S.No.	Topic	No. of lectures
1	Genetic structure of population in relation to mode of pollination	1
2	Historical aspect of heterosis - Nomenclature and definitions of heterosis	1
3.	Heterosis in natural population and inbred population	1
4	Inbreeding-Introduction and effect of inbreeding, coefficient of inbreeding, Inbreeding depression	1
5	Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops	1
6	Pre Mendelian and Post-Mendelian ideas about heterosis.	1
7	Genetic theories of heterosis- Genetic basis of heterosis-dominance and overdominance hypothesis	1
9	Physiological and Biochemical basis of heterosis	1
9	Molecular factors underlining heterosis	1
10	Prediction of heterosis from various crosses	1
11	Inbreeding depression, frequency of inbreeding and residual heterosis in F2 and segregating populations,	1
12	Importance of inbreeding in exploitation of heterosis	1
13	Relationship between genetic distance and expression of heterosis	1
14	Divergence and Genetic Distance analyses	1
15	Morphological and molecular genetic distance in predicting heterosis	1
16	Development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis.	1
17	Types of male sterility and use in heterosis breeding	1
18	Maintenance, transfer and restoration of different types of male sterility	1
	Self-incompatibility and uses of SI in development of hybrids	1
19	Hybrid seed production system using 3-line, 2-line and 1-line system	1
20	Development of inbreds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids.	1

21	Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops;	1
22	Male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagated crops	1
23	Problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid	1
24	Application of biotechnology in heterosis breeding- molecular markers, doubled haploids, somatic hybridization.	1
25	Organellar heterosis and complementation	1
26	Creation of male sterility through genetic engineering and its exploitation in heterosis	1
27	Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops	1
28	Heterosis breeding in Rice	1
29	Heterosis breeding in Maize	1
30	Heterosis breeding in pearlmillet	1
31	Heterosis breeding in sorghum	1
32	Heterosis breeding in oilseed crops	1

Lecture schedule : Practical

S.No.	Topic	No. of lectures
1	Selection indices and selection differential – Calculations and interpretations	1
2	Male sterile line characterization in millets; Using morphological descriptors	1
3	Restorer line identification and diversification of male sterile sources	1
4	Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; Ways of overcoming them	1
5	Male sterile line creation, diversification and restoration in forage crops	1
6	Understanding the difficulties in breeding apomicts;	1
7	Estimation of heterotic parameters in self, cross and asexually propagated crops - Estimation from the various models for heterosis parameters	1
8	Practical aspects of hybrid seed production using different crossing techniques	1
9	Hybrid seed production in cereals	1
10	Hybrid seed production in pulses	1
11	Hybrid seed production in oilseed crops	1
12	Hybrid seed production in fibre crops	1
13	Hybrid breeding at National and International level	1
14	Identification of maintainers and restorers (maize, sorghum, bajra, wheat, rice and brassica	1
15	Identification and characterization of important hybrids in field crops	1
16	Field visit of hybrid seed production plots	1

Suggested Readings

Proceedings of *Genetics and Exploitation of Heterosis in Crops* - An International Symposium CIMMYT, 1998.

Akin E. 1979. *The Geometry of Population Genetics*. Springer-Verlag.

Ben Hiu Lin. 1998. *Statistical Genomics–Linkage, Mapping and QTL Analysis*. CRC Press.

De Joung G. 1988. *Population Genetics and Evolution*. Springer-Verlag.

Hartl DL. 2000. *A Primer of Population Genetics*. 3rd Ed. Sinauer Assoc.

Mettler LE & Gregg TG. 1969. *Population Genetics and Evolution*. Prentice-Hall.

Montgomery DC. 2001. *Design and Analysis of Experiments*. 5th Ed. Wiley & Sons.

Richards AJ. 1986. *Plant Breeding Systems*. George Allen & Unwin.

Srivastava S & Tyagi R. 1997. *Selected Problems in Genetics*. Vols. I, II. Anmol Publ.

03MPBG103 Modern Concepts in Crop Production 3(3+0)

Objective

To teach the basic concepts of soil management and crop production.

Theory:

Agronomic aspects in food security; Crop growth and production in relation to climate change; Agro ecological and agroclimatic zones of India; C oncept of potential yield; Modern concepts in tillage - zero, minimum and conservation tillage; Optimization of plant population and planting geometry in relation to soil fertility, solar radiation and available moisture regimes; Mitscherlich , Baule and Inverse yield : nitrogen laws; Biotic and abiotic stresses; Concept of ideal plant type; Organic farming, Physiology of grain yield in cereals; Crop growth analysis; Crop modelling in agronomic systems; Precision agriculture; Growth regulators and their role in agriculture; Designer crops; Vermi-technology; Agro biodiversity; Seed priming; ; I nd i geno us technolo gical kno wled ge; Herb icid e resistance in weeds; Allelopathy in agriculture ; Plant nutrition and disease tolerance in field crops.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Population and food requirement	1
2	Agronomic techniques for food security, crop nutrition, value addition	2
3	Effect of climate change on crop production	1
4	Direct and interactive effect of different climatic parameters on crop production	2
5	Agroecological and agroclimatic zones of India and their introduction	2
6	Concept of potential yield	1
7	I ntrod uctio n to mo der n co ncep ts o f tillage - zer o tillage minimum tillage, furrow irrigated raised bed system, resource conservation	3
8	Conservation tillage - its advantages, disadvantages , types and Methods	1
9	Relationship between plant population and yield and response curves	1
10	Optimum plant population in relation to soil fertility and solar radiation	1
11	Mitscherlich equation, Baule unit and inverse yield: nitrogen laws	2
12	Abiotic and biotic stresses	2
13	Definition and concept of ideal plant type	1
14	Characteristics of an ideotype plant for dryland agriculture	1
15	Ideotype plant for wheat	1
16	Organic farming – definition, differences between conventional and organic farming and principles and components of organic farming	2
17	Physiology of grain yield in cereals	2
18	Growth curves and analysis of crop growth : LAI, CGR, RGR, NAR, LAD	2
19	Crop model-definition, concept and types (empirical & mechanistic)	1
20	Scientific basis of modelling	1
21.	Model applications	1
22	Precision agriculture-definition, basic concept, scope and approach	1
23.	Technologies for precision agriculture: computers, geographical information system (GIS), global positioning, system (GPS), sensors, etc.	2
24.	Plant growth regulators-definition,types and their role in crop Production	2
25	Designer crops - concept and importance	2
26	Vermi- technology, meaning, methods and scope	2
27	Agro- biodiversity- definition, effects, threats and conservation	2
28	Seed priming- concept, importance and use in crop production	1
29	I nd igeno us techno lo gical kno wled ge and its use in crop production	1
30	Herbicide resistance in weeds – meaning and management of resistant weeds	2
31	Allelopathy in agriculture	1
32	Plant nutrition and disease tolerance in field crops	1

Suggested Readings:

Gardner, F.P.;Pearce, G.R. and Michell, R.I. Physiology of Crop Plants, Scientific Pub., Jodhpur.

S.P. Palaniappan and Shivarama,K. 1996. Cropping Systems in the Tropics - Principles and Management. New Age International Pub.

Fageria, N.K. 1992. Maximising crop yields. Marcel Dekker, New York.

Reddy,S.R. 2000. Principles of Agronomy. Kalyani Pub. New Delhi.

Sankaran, S. and Mudaliar ,T.V.S. l997. Principles of' Agronomy. The Bangalore Printing and Pub. Bangalore.

Redford, J. 1967. Growth Analysis formulae: Their use and abuse. Crop Science. 76:171 - 175.

Singh, G.; Kolar, J.S. and Sekhon, H.S. 2002 Recent Advances in Agronomy (Ed). ISA, Publication, New-Delhi.

03MPBG104 Principles and Practices of Weed Management 3(2+1)

Objective

To familiarize the students about the weeds, herbicides and methods of weed control.

Theory

Weed–biology, ecology and classification; history, development and classification of herbicides, their properties, mode of action and uses, basis of selectivity of herbicides; herbicide mixtures, adjuvants and safeners; weed control principles and management practices in important grain crops, oilseeds, pulses, sugar, fibre crops, tuber crops and forage crops; vegetables and orchards; weed control under specific situations viz. intercropping systems, non cropped areas and drylands; noxious farm weeds and parasitic weeds and their control; fate of herbicides in soil; herbicide - pesticides and fertilizer interactions; allelopathic effect; integrated weed management; problem of aquatic weeds particularly water hyacinth, hydrilla and typha grass in Rajasthan and their possible control measures; weed control through bio herbicides and myco- herbicides; herbicide resistance in weeds and crops.

Practical:

Identification of common k*harif, rabi* and perennial weeds of crop fields, road sides, waste lands and irrigation channels; familiarization with trade names, common names, uses, cost and source of availability of herbicides; calibration of sprayer and maintenance (before and after use); study of different herbicidal formulations; calculation on herbicidal requirement for field crops and aquatic situation; application of herbicides in field crops; control of some noxious weeds by cultural and chemical means; study on weed control efficiency and calculation on weed infestation and weed index; preparation of weed herbarium, methodology for weed control research and precautions in handling or storage of herbicides.

Lecture schedule – Theory

S. No.	Topic	No. of lectures
1	Weeds- biology, ecology and classification	2
2	Herbicides -	2
	a) History, development and classification of herbicides	2
	b) Properties of herbicides	2
	c) Mode of action and uses of herbicides	2
	d) Basis of selectivity of herbicides	2
3	Herbicide mixtures, adjuvants and safeners	2
4	Weed control principles and management practices in important crops	1
	a) Grain crops	2
	b) Oilseeds and pulses	2
	c) Sugar and fibre crops	1
	d) Tuber and forage crops	2
	e) Vegetable crops	2
	f) Orchards	1
5	Weed control under specific situations – intercropping system, drylands and non-cropped area	1
6	Noxious farm weeds, parasitic weeds and their control	1
7	Fate of herbicides in soil	2
8	Herbicide- pesticides and fertiliser interactions	1
9	Allelopathic effects	1
10	Integrated weed management	1
11	Problem of aquatic weeds particularly water hyacinth, hydrilla and typha grass in Rajasthan and their possible control measures	1
12	Weed control through bio-herbicides and myco- herbicides	1
13	Herbicide resistance in weeds and crops	1

Lecture schedule-Practical

S.No.	Topic	No. of lectures
1	Identification of common *Kharif* and *Rabi* weeds	
2.	Identification of perennial weeds of crop fields, road sides, wastelands and irrigation channels	1
3.	Familiarization with trade names, common names, uses, cost and sources of availability of herbicides	1
4.	Calibration of sprayers and maintenance (before and after use)	1
5.	Study of different herbicidal formulations	1
6.	Calculation on herbicidal requirement for field crops under aquatic situations	2
7.	Application of herbicides in field crops	2
8.	Control of some noxious weeds by cultural and chemical means	1
9.	Study on weed control efficiency and calculation on weed infestation and weed index	1

10.	Preparation of weed herbarium	2
11.	Methodology for weed control research	2
12	Precautions in handling or storage of herbicides	1

Suggested Readings :

Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.
Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley Inter-Science.
Gupta OP. 2007. *Weed Management–Principles and Practices.* Agrobios.
Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.
Rao VS. 2000. *Principles of Weed Science.* Oxford & IBH.
Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani.
Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic. Press

BHAGWANT UNIVERSITY

Established by Govt. of Raj. & Recognised by UGC

Sikar Road, Ajmer

RAJASTHAN

Syllabus

M.Sc. (Soil Science)

Faculty of Agriculture

Bhagwant University, Ajmer (Raj.)

M.Sc. (Ag.) Course Programs

SOIL SCIENCE

	Semester I		
BU Course No.	**Course No**	**Course Title**	**Credit Hours**
01MSOI101	**SOILS 511**	Soil Chemistry	**3(2+1)**
01MSOI102	**SOILS 512**	Soil mineralogy, genesis,, classification and soil survey	**3(2+1)**
01MSOI103	**SOILS 513**	Analytical techniques and instrumental methods in soil and plant analysis	**3(1+2)**
01MSOI104	**AGRON 511**	Agrometeorology and crop weather forecasting	**3(2+1)**
	Semester II		
02MSOI101	**SOILS 52**	Soil fertility and fertilizer use	**4(3+1)**
02MSOI102	**SOILS 522**	Soil biology and biochemistry	**3(2+1)**
02MSOI103	**SOILS 524**	Soil, water and air pollution	**3(2+1)**
02MSOI104	**SOILS 525**	Fertilizer technology	**2(2+0)**
02MSOI105	**STAT 521**	Experimental design	**3(2+1)**
	Semester III		
03MSOI101	**SOILS 531**	Soil Physics	**3(2+1)**
03MSOI102	**SOILS 532**	Management of problem soils and waters	**3(2+1)**
03MSOI103	**AGRON 521**	Modern concepts in crop production	**3(3+0)**
03MSOI104	**AGRON 522**	Principles and practices of weed management	**3(2+1)**
	Semester IV		
04MSOI101	**SOILS 541**	M.Sc. Seminar	**1(0+1)**
04MSOI102	**SOILS 542**	Comprehensive	**2(0+2)**
04MSOI103	**SOILS 543**	M.Sc. Research	**15**

SOIL SCIENCE

01MSOI101 Soil Chemistry 3(2+1)

Objective

To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

Theory

Chemical (elemental) composition of the earth's crust and soils, Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics, Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions, Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement,; anion and ligand exchange – innersphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition, Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects, Chemistry of acid soils; active and potential acidity; lime potential,; sub-soil acidity, Chemistry of salt-affected soils and amendments, Chemistry and electrochemistry of submerged soils.

Practical

Determination of CEC and AEC of soils, Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH, meter and conductivity meter, Adsorption-desorption of phosphate/sulphate by soil using simple, adsorption isotherm, Determination of titratable acidity of an acid soil by BaCl2-TEA method.

Lecture schedule—Theory

S. No.	Topic	No. of lecture
1.	Chemical (elemental) composition of the earth's crust and soils.	1
2.	Elements of equilibrium thermodynamics, chemical equilibria,electrochemistry and chemical kinetics.	1
3.	Inorganic and organic colloids - origin of charge,	1
4.	Concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils;	2
5.	Diffuse double layer theories of soil colloids,	2
6.	Zeta potential,	2
7.	Stability, coagulation/flocculation and peptization of soil colloids;	2
8.	Eelectrometric properties of soil colloids	1
9.	Sorption properties of soil colloids;	1
10.	Fractionation of soil organic matter and different fractions, clay-organic interactions.	2
11.	Theories of cation exchange based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept,	2
12.	Clay-membrane electrodes and ionic activity measurement,	1
13.	Anion and legend exchange – innersphere and outer-sphere surface complex formation	1
14.	Fixation of oxyanions,hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on legend exchange,	1
15.	AEC, CEC;	1
16.	Experimental methods to study ion exchange phenomena and practical implications in plant nutrition.	1
17.	Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects.	3
18.	Chemistry of acid soils; active and potential acidity; lime potential,; sub-soil acidity	2
19.	Chemistry of salt-affected soils and amendments;	2
20.	Chemistry of submerged soils.	1
21.	Electrochemistry of submerged soils.	2

Lecture schedule—Practical

S. No	Topic	No. of lecture
1.	Determination of CEC of soils	2
2.	Determination of AEC of soils	2
3.	Analysis of equilibrium soil solution for pH	1
4.	Analysis of equilibrium soil solution for Eh	2
5.	Analysis of equilibrium soil solution for EC	1
6.	Adsorption-desorption of phosphate by soil using simple adsorption isotherm	3
7.	Adsorption-desorption of sulphate by soil using simple adsorption isotherm	3
8.	Determination of titratable acidity of an acid soil by BaCl2-TEA method	2

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil*. Oxford and IBH.
Bolt GH &Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.
Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons. Greenland DJ & Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons. McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. 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 & Sons.
Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

01MSOI102 Soil Mineralogy, Genesis, Classification And Survey 3(2+1)

Objective

To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis in terms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

Fundamentals of crystallography, isomorphism and polymorphism, Structural chemistry, Classification of minerals, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; amorphous soil constituents and other non-crystalline silicate minerals; clay minerals in Indian soils, soil morphology and micromorphology, Factors of soil formation, soil forming processes, weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils, Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness, Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps, Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

Practical

Identification of rocks and minerals, Morphological properties of soil profile in different landforms, Classification of soils using soil taxonomy, Grouping soils using available data base in terms of soil quality, Aerial photo and satellite data interpretation for soil and land use, Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales, Land use planning exercises using conventional and RS tools.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Fundamentals of crystallography, isomorphism and polymorphism	1
2.	Structural chemistry and Classification of minerals	1
3.	Chemical composition and properties of clay minerals	2
4.	Genesis and transformation of crystalline and non-crystalline clay minerals	2
5.	Amorphous soil constituents and other non-crystalline silicate minerals; clay minerals in Indian soils.	2
6.	Soil morphology and micromorphology	1
7.	Soil formation, Factors of soil formation, soil forming processes	2
8.	Weathering of rocks and mineral transformations	3
9.	Soil profile; weathering sequences of minerals with special reference to Indian soils	2
10.	Concept of soil individual and soil classification systems	2
11.	Historical developments and modern systems of soil classification with special emphasis on soil taxonomy	2
12.	Soil classification, soil mineralogy and soil maps – usefulness.	1
13.	Soil survey and its types; soil survey techniques - conventional and modern	2
14.	Soil series – characterization and procedure for establishing soil series	1
15.	Benchmark soils and soil correlations	1
16.	Soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps	2
17.	Landform – soil relationship; major soil groups of India with special reference to respective states	1
18.	Land capability classification and land Irrigability classification	1
19.	Land evaluation and land use type (LUT) – concept and application	2
20.	Approaches for managing soils and landscapes in the framework of agro-ecosystem.	1

Lecture schedule—Practical

S. No.	Topic	No. of lecture
1.	Identification of rocks	1
2.	Identification of minerals	1
3.	Morphological properties of soil profile in different landforms	2
4.	Classification of soils using soil taxonomy	2
5.	Grouping soils using available data base in terms of soil quality	2
6.	Aerial photo and satellite data interpretation for soil and land use	2
7.	Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales	4
8.	Land use planning exercises using conventional and RS tools	2

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ. Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.
Grim RE. 1968. *Clay Mineralogy*. McGraw Hill. Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi. Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi
Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.
USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.
Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.
Wilding LP &Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*. Elsevier.
Wilding NE &Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*. I. *Concept and Interaction*. Elsevier.

01MSOI103 Analytical techniques and instrumental methods in soil and plant analysis 3(1+2)

Objective

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Theory

Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods.

Practical

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils. Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity, analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods, drawing normalized exchange isotherms; measurement of redox potential.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Principles of visible, ultraviolet and infrared spectrophotometery	2
2.	Principle and instrumentation of atomic absorption spectrophotometer	2
3.	Principles of flame-photometry	1
4.	Principles and instrumentation of inductively coupled plasma spectrometry	2
5.	Principles and instrumentation of chromatographic techniques	4
6.	Principles of mass spectrometry and X-ray defractrometery	2
7.	Principle of identification of minerals by X-ray by different Methods	3

Lecture schedule—Practical

S.No	Topic	No. of lecture
1.	Analytical chemistry – Basic concepts, techniques and calculations	3
2.	Principle of analytical instruments and their calibration for soil and plant analysis	2
3.	Determination of available nitrogen in soil	1
4.	Determination of available phosphorus in soil	1
5.	Determination of available potassium in soil	1
6.	Determination of available sulphur in soil	1
7.	Determination of available Boron in soil	1
8.	Determination of available molybdenum in soil	1
9.	Determination of iron, cupper, manganese and zinc in soil	1
10.	Determination of potential buffering capacity of phosphorus	1
11.	Determination of potential buffering capacity of potassium	1
12.	Determination of ammonium fixation capacity of soil	1
13.	Determination of potassium fixation capacity of soil	1
14.	Determination the cation exchange capacity of soil	1
15.	Determination the anion exchange capacity of soil	1
16.	Determination of calcium and magnesium in soil	1
17.	Determination of Sodium in soil	1
18.	Estimation of root cation exchange capacity	1
19.	Determination of nitrogen in plant	1
20.	Determination of phosphorus in plant	1
21.	Determination of potassium in plant	1
22.	Determination of sulphur in plant	1
23.	Determination of calcium and magnesium in plant	1
24.	Determination of boron in plant	1
25.	Determination of molybdenum in plant	1
26.	Determination of iron, cupper, manganese and zinc in plant	1
27.	Estimation of root cation exchange capacity	1
28.	Drawing normalized exchange isotherms; measurement of redox potential	2

Suggested Readings

Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes& Sons. Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.

Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.

Kenneth Helrich 1990. *Official Methods of Analysis* Association of Official Analytical Chemists. Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison. Piper CE. *Soil and Plant Analysis*. Hans Publ.

Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis – A Methods Manual*. IARI, New Delhi. Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.

Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi. Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman

01MSOI104 Agrometeorology and Crop Weather Forecasting 3(2+1)

Objective

To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

Theory:

Agro meteorology: aim, scope and development in relation to crop environment, composition of atmosphere, distribution of atmospheric pressure, Solar radiation : characteristics, energy balance of atmosphere system, radiation distribution in plant canopies, radiation utilization by field crops, photosynthesis and efficiency of radiation utilization by crops, energy budget of plant canopies, Environmental temperature: soil, air, canopy temperature, temperature profile in air, soil and crop canopies, soil and air temperature effects on plant processes, regulation of air, soil temperature for protection against frost and hot winds, Environmental moisture and evaporation, measures of atmospheric moisture, temperature, relative humidity, vapour pressure and their relationship, evapotranspiration and meteorological factors determining evapotranspiration, Modification of plant environment: artificial rain making, controlling heat load, heat trapping and shedding, protection from cold, reduction in sensible and latent heat flux, Monsoon: monsoon and their origin, characteristics of monsoon, onset and progress of monsoon, withdrawal of monsoon, Weather forecasting in India: short, medium and long range forecasting, benefits of weather service to agriculture, forecasting of destructive frost, soil moisture forecast, phenological forecast, crop yield forecast, Aero-space science and remote sensing : application in agriculture, present status of remote sensing in India, Atmospheric pollution and its effect on climate and crop production.

Practical

Agrometeorological observatory- classes, site selection, layout and installation of meteorological instruments; handling of meteorological instruments; measurement of weather parameters; working out agroclimatic indices; maintenances of record; calculation of daily, weekly and monthly means; visit to state remote sensing centre, Jodhpur/Jaipur; measurement of soil temperature in different soil conditions/depths; interpretation and use of weather data; rainfall analysis for variability; moisture availability indices for an arid and a humid district, length of growing season, fitting cropping systems; preparation of weather maps, synoptic charts and weather reports; preparation of crop weather calendars, to become familiar with agro advisory service bulletins visit to ARS, Durgapura/Bikaner.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Agro meteorology - aim, scope and development in relation to crop environment	2
2	Composition of atmosphere, distribution of atm. pressure	1
3	Solar radiation - characteristics	1
4	Energy balance of atmosphere system	1
5	Radiation distribution in plant canopies, radiation utilization by field crops	2
6	Photosynthesis and efficiency of radiation utilization by crops	2
7	Energy budget of plant canopies	1
8	Environmental temperature- soil, air, canopy temperature, temperature profile in air, soil, crop canopies	2
9	soil and air temperature effects on plant processes	2
10	Regulation of air, soil temperature for protection against frost and hot winds	2
11	Environmental moisture and evaporation - measures of atmospheric moisture, temperature, relative humidity, vapour pressure and their relationship	2
12	Evapotranspiration and meteorological factors determining evapotranspiration	2
13	Modification of plant environment, artificial rain making, controlling heat load, heat trapping and shedding	2
14	Protection from cold, reduction in sensible and latent heat flux	1
15	Monsoon and their origin, characteristics of monsoon	1
16	Onset and progress of monsoon withdrawal of monsoon	1
17	Weather forecasting in India: short, medium and long range forecasting	2
18	Benefits of weather service to agriculture, forecasting of destructive frost, soil moisture forecast, phenological forecast, crop yield forecast etc	2
19	Aero-space science and remote sensing - application in agriculture, present status of remote sensing in India.	2
20	Atmospheric pollution and its effect on climate and crop production	1

Lecture schedule- Practical

S. No.	Topic	No. of lectures
1	Agro meteorological observatory – classes, site selection, layout and installation procedures for meteorological instruments	1
2	Handling of meteorological instruments	1
3	Measurement of weather parameters	1
4	Working out agro climatic indices	1
5	Maintenance of records	1
6	Calculation of daily, weekly and monthly means	2
7	Visit to state Remote Sensing Centre, Jodhpur/Jaipur	1
8	Measurement of soil temperature in different soil conditions/depths	1
9	Interpretation and use of weather data	1
10	Rainfall analysis for variability	2
11	Moisture availability indices for an arid district	1
12	Moisture availability indices for a humid district	1
13	Length for growing season, fitting cropping systems	1

14	Preparation of weather maps, synoptic charts & weather reports	1
15	Preparation of crop weather calendar	1
16	To become familiar with Agro-advisory-service bulletins/	1

Suggested Readings:

S. Mavi (1994). Introduction to Agrometeorology. Oxford & IBH Publishing Co.
New Delhi.
P.A. Menon (1989). Our weather. National Book Trust, New Delhi.
A.A. Rama Sastu (1984). Weather and Weather forecasting Publication Division, GOI.
P.K. Das (1992). The Monsoon. National Book Trust, New Delhi.
S. Venkateraman and A. Krishnan. Crops and Weather. Indian Council of Agricultural Research, New Delhi.
Critchfield, H.J. 1995. General Climatology, Prentice Hall of India Pvt. Ltd., New Delhi
R.S. Gena and S.P. Seetharaman (1991). Natural Resource Management: The Role of Remote sensing in decision making. Oxford & IBH Publishing Co. New Delhi.
K.L. Joshi, Sinha and D.P. Gupta (1985). Physical Geography, National Council of Educational Research and Training, New Delhi.
VasirajuRadha Krishna Murthy (1995). Practical Manual on Agricultural Meteorology, Kalyani Publishers, Ludhiana.
D.S. Lal, 1998. Climatology. ShardaPustakBhawan.
S.R. Ghadekar, 1991. Meteorology, Agromet Publishers, Nagpur.
A.K. Sacheti, 1985. Agricultural Meteorology- Instructional-cum-Practical Manual. NCERT, New Delhi. Mavi H.S. and Tuper G.J. 2004. Agrometeorology: Principles and Application of Climate Studies in Agriculture. Haworth Press.
Vashneya M.C. and Balakrishana Pillai P. 2003. Textbook of Agricultural Meteorology, ICAR.

02MSOI101 Soil Fertility And Fertilizer Use 4(3+1)

Objective

To impart knowledge about soil fertility and its control, and to understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.

Theory

Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms, soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation -types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency, soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions, potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions, sulphur - source, forms, fertilizers and their behavior in soils; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers, micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability, common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions, fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site- specific nutrient management; plant need based nutrient management; integrated nutrient management, soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

Practical:

Chemical analysis of soil for total N,P&K and available nutrients (N, P, K, S, Cu, Fe, Mn ,Zn, Mo. B), analysis of plants for essential elements (N, P, K, S, Cu, Fe, Mn, Zn, Mo, B)

Lecture schedule—Theory

S. No.	Topic	No. of lecture
1.	Soil fertility and soil productivity	1
2.	Nutrient sources – fertilizers and manures	1
3.	Essential plant nutrients - functions and deficiency symptoms	2
4.	Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification	2
5.	Biological nitrogen fixation -types, mechanism, microorganisms and factors affecting	2
6.	Nitrogenous fertilizers and their fate in soils	2
7.	Management of nitrogenous fertilizer in lowland and upland conditions for high fertilizer use efficiency.	2
8.	Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils	2
9.	Factors affecting phosphorus availability in soils	1
10.	Phosphatic fertilizers - behavior in soils and management under field conditions.	2
11.	Potassium - forms, equilibrium in soils and its agricultural significance	1
12.	Mechanism of potassium fixation in soil	2
13.	Management of potassium fertilizers under field conditions	1
14.	Sulphur - source, forms, fertilizers and their behavior in soils	1
15.	Calcium and magnesium– factors affecting their availability in soils	2

16.	Management of sulphur, calcium and magnesium fertilizers under field conditions	2
17.	Micronutrients – critical limits in soils and plants	1
18.	Factors affecting their availability and correction of their deficiencies in plants	3
19.	Role of chelates in nutrient availability	1
20.	Common soil test methods for fertilizer recommendations	2
21.	Quantity– intensity relationships	1
22.	Soil test crop response correlations and response functions	2
23.	Fertilizer use efficiency and factors affecting the FUE	2
24.	Blanket fertilizer recommendations – usefulness and limitations	1
25.	Site-specific nutrient management	1
26.	Plant need based nutrient management	1
27.	Integrated nutrient management and its importance and components	1
28.	Soil fertility evaluation : Biological methods, use of visual symptoms of nutrient deficiency or toxicity	1
29.	Soil fertility evaluation : Plant analysis method – DRIS methods, critical levels in plants, rapid tissue tests, indicator plants	1
30.	Soil fertility evaluation: Soil analysis methods – critical levels of different nutrients in soil.	2
31.	Interpretation and calibration of soil test values and fertilizer recommendation to crops	1
32.	Soil quality in relation to sustainable agriculture	1

Lecture schedule—Practical

S. No.	Topic	No. of lecture
1.	Determination of Total nitrogen in soil	1
2.	Determination of Total phosphorus in soil	1
3.	Determination of Total potassium in soil	1
4.	Determination of available nitrogen in soil	1
5.	Determination of available phosphorus in soil	1
6.	Determination of available potassium in soil	1
7.	Determination of available sulphur in soil	1
8.	Determination of available Boron in soil	1
9.	Determination of available molybdenum in soil	1
10.	Determination of iron, cupper, manganese and zinc in soil	1
11.	Determination of nitrogen in plant	1
12.	Determination of phosphorus in plant	1
13.	Determination of potassium in plant	1
14.	Determination of sulphur in plant	1
15.	Determination of boron in plant	1
16.	Determination of molybdenum in plant	1
17.	Determination of iron, cupper, manganese and zinc in plant	1

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
Kabata-Pendias A &Pendias H. 1992. *Trace Elements in Soils and Plants*. CRC Press. Kannaiyan S, Kumar K &Govindarajan K. 2004. *BiofertilizersTechnology*. Scientific Publ. Leigh JG. 2002. *Nitrogen Fixation at the Millennium*. Elsevier.
Mengel K &Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.

Objective

To teach students the basics of soil biology and biochemistry, including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

Theory

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota, microbiology and biochemistry of root-soil interface; phyllosphere; rhizoshpere, soil, enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora, microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, humus formation; cycles of important organic nutrients, biodegradation of organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil, preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost, biofertilizers – definition, classification, specifications, method of production and role in crop production, BIS standards for biofertilizer for quality control.

Practical

Determination of soil microbial population, soil microbial biomass (C N P), fractionation of organic matter (HA, FA, Humin, Lignin and humus) and functional groups, soil enzymes, measurement of important soil microbial processes such as nitrification, N2 fixation, S oxidation, P solubilization.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Soil microbiology, Soil biota, soil microbial ecology	1
2.	Classification of micro-organism and types of organisms in different soils	2
3.	Soil microbial biomass	1
4.	Microbial interactions	1
5.	Soil biota in culturale and un-culturale land and factors affecting it	1
6.	Microbiology and biochemistry of root-soil interface	2
7.	Phyllosphere	1
8.	Rhizoshpere	1
9.	Soil enzymes, origin, activities and importance	1
10.	Soil characteristics influencing growth and activity of microflora.	1
11.	Microbial transformations of nitrogen in soil	1
12.	Microbial transformations of Phosphorus in soil	1
13.	Microbial transformations of Sulphur in soil	1
14.	Microbial transformations of Iron in soil	1
15.	Microbial transformations of manganese in soil	1
16.	Biochemical composition and biodegradation of soil organic matter and crop residues	2
17.	Humus formation; cycles of important organic nutrients.	2
18.	Biodegradation of organic wastes and their use for production of biogas and manures	2
19.	Biotic factors in soil development	1
20.	Microbial toxins in the soil	1

21.	Preparation and preservation of farmyard manure and animal manure	1
22.	Composting methods and Rural and urban compost	1
23.	Vermicomposting	2
24.	Biofertilizers – definition, classification, specifications, method of production and role in crop production	2
25.	BIS standards for biofertilizer for quality control	1

Lecture schedule—Practical

S. No.	Topic	No. of lecture
1.	Determination of soil microbial population (Fungi, Bacteria and Actinomycetes)	2
2.	Determination of Soil microbial biomass Carbon	2
3.	Determination of Soil microbial biomass Nitrogen	2
4.	Determination of Soil microbial biomass phosphorus	2
5.	Fractionation of organic matter (HA, FA, Humin, Lignin and humus) and functional groups	4
6.	Measurement of important soil microbial processes such as nitrification, N2 fixation, S oxidation, P solubilization	4

Suggested Readings

Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
Metting FB. 1993. *Soil Microbial Ecology – Applications in Agricultural and Environmental Management*. MarceDekker.
Paul EA & Ladd JN. 1981. *Soil Biochemistry*. Marcel Dekker.
Reddy MV. (Ed.). *Soil Organisms and Litter in the Tropics*. Oxford & IBH.
Russel RS. 1977. *Plant Root System: Their Functions and Interaction with the Soil*. ELBS & McGraw Hill. Stotzky G &Bollag JM. 1993. *Soil Biochemistry.* Vol. VIII. Marcel Dekker.
Sylvia DN. 2005. *Principles and Applications of Soil Microbiology*. Pearson Edu.
Wild A. 1993. *Soil and the Environment - An Introduction*. CambridgeUniv. Press.

02MSOI103 Soil, water and air pollution 3(2+1)

Objective

To make the students aware of the problems of soil, water and air pollution associated with use of soils for crop production.

Theory

Soil, water and air pollution problems associated with agriculture, nature and extent, nature and sources of pollutants

– agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings, sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal, pesticides – their classification, behavior in soil and effect on soil microorganisms, toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health, Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases – carbon dioxide, methane and nitrous oxide, remediation/amelioration of contaminated soil and water; soil as a sink for waste disposal, soil and water quality standards.

Practical

Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants, estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammonical nitrogen and phosphorus, heavy metal content in effluents, heavy metals in contaminated soils and plants, analysis of soil and plant samples for pesticides residues, visit to various industrial sites to study the impact of pollutants on soil and plants.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Soil, water and air pollution problems associated with agriculture, nature and extent	3
2.	Air pollution causes, effects and control	1
3.	Water pollution causes, effects and control	1
4.	Soil pollution causes, effects and control	1
5.	Nature and sources of agricultural pollutants and their CPC standards and effect on plants, animals and human beings	1
6.	Nature and sources of industrial pollutants and their CPC standards and effect on plants, animals and human beings	2
7.	Nature and sources of urban wastes pollutants and their CPC standards and effect on plants, animals and human beings	2
8.	Nature and sources of fertilizers and pesticides pollutants and their CPC standards and effect on plants, animals and human beings	2
9.	Nature and sources of pollutants as acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings	2
10.	Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal	3
11.	Pesticide and its classification	1
12.	Pesticides behavior in soil and effect on soil microorganisms	2
13.	Toxic elements – their sources, behavior and effect on soil	1
14.	Effect of toxic elements on nutrients availability and plant and human health	2
15.	Pollution of water resources due to leaching of nutrients and pesticides from soil	1
16.	Emission of greenhouse gases – carbon dioxide, methane and nitrous oxide	3
17.	Remediation/amelioration of contaminated soil and water	2
18.	Soil as a sink for waste disposal, soil and water quality standards.	2

Lecture schedule—Practical

S. No.	Topic	No. of lecture
1.	Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants	2
2.	Estimation of total dissolved and suspended solids heavy metal content in effluents	1
3.	Determination of chemical oxygen demand (COD) in effluents	1
4.	Determination of biological demand (BOD) in effluents	1
5.	Determination of nitrate nitrogen in effluents	1
6.	Determination of amonical nitrogen in effluents	1
7.	Determination of phosphorus in effluents	1
8.	Determination of heavy metal content in effluents	2
9.	Analysis of temporary and total hardness of water sample by titration	1
10.	Determination of heavy metal content in contaminated soil	3
11.	Determination of heavy metal content in plant samples	2

Suggested Readings

Lal R, Kimble J, Levine E & Stewart BA. 1995. *Soil Management and Greenhouse Effect.* CRC Press. Middlebrooks EJ. 1979. *Industrial Pollution Control*. Vol. I. *Agro-Industries*. John Wiley Interscience. Ross SM. *Toxic Metals in Soil Plant Systems*. John Wiley & Sons.
Vesilund PA & Pierce 1983. *Environmental Pollution and Control*. Ann Arbor Science Publ.

02MSOI104 Fertilizer technology 2(2+0)

Objective

To impart knowledge about how different fertilizers are manufactured using different kinds of raw materials and handling of fertilizers and manures.

Theory

Fertilizers – production, consumption and future projections with regard to nutrient use in the country and respective states; fertilizer control order, manufacturing processes for different fertilizers using various raw materials, characteristics and nutrient contents, recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order, new and emerging issues in fertilizer technology – production and use of slow and controlled release fertilizers, supergranules fertilizers and fertilizers for specific crops/situations.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Fertilizers – production, consumption and future projections with regard to nutrient use in the country and respective states	3
2.	Fertilizer control order	2
3.	Manufacturing processes for nitrogenous fertilizers using various raw materials, characteristics and nutrient contents.	4
4.	Manufacturing processes for phosphatic fertilizers using various raw materials, characteristics and nutrient contents.	3
5.	Manufacturing processes for potassic fertilizers using various raw materials, characteristics and nutrient contents.	2
6.	Manufacturing processes for Secondary nutrients fertilizers using various raw materials, characteristics and nutrient contents.	2
7.	Manufacturing processes for micro nutrient fertilizers using various raw materials, characteristics and nutrient contents.	3
8.	Manufacturing processes for mix and complex fertilizers using various raw materials, characteristics and nutrient contents.	3
9.	Recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order	2
10.	New and emerging issues in fertilizer technology	2
11.	New and emerging issues in production and use of slow and controlled release fertilizers	3
12.	Supergranules fertilizers	1
13.	fertilizers for specific crops/situations and applications	2

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils.* Pearson Edu.

Fertilizer (Control) Order, 1985 and the Essential Commodities Act. FAI,New Delhi. Kanwar JS. (Ed.). 1976. *Soil Fertility: Theory and Practice*. ICAR.

Olson RA, Army TS, Hanway JJ & Kilmer VJ. 1971. *Fertilizer Technologyand Use.* 2nd Ed. Soil Sci. Soc. Am.

Madison.

02MSOI105 Experimental Designs 3(2+1)

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. 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

Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control, Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design, Factorial experiments, (symmetrical as well as asymmetrical), orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment, 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, resolvable designs and their applications ~ concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

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; Analysis of resolvable designs; Fitting of response surfaces.

Lecture schedule: Theory

S. No.	Topics	No. of Lect.
1.	Basic concepts of design of experiment	2
2.	Basic principles of designs	3
3.	Uniformity trials	1
4.	Size and shape of plots and blocks	1
5.	Analysis of variance and transformations	2
6.	CRD, RBD and LSD	3
7.	Factorial experiments	4
8.	Confounding in symmetrical factorial experiments	2
9.	Factorial experiments with control treatment	2
10.	Split plot design	2
11.	Strip plot design	2
12.	Analysis of covariance and missing plot techniques	2
13.	crossover designs	1
14.	resolvable designs	1
15.	Response surfaces	2
16.	Experiments with mixtures	2

Lecture schedule: Practical

S. N.	Topics	No. of Lectures
1.	Formation of plots	1
2.	Formation of blocks	1
3.	Analysis of CRD	1
4.	Analysis of RBD	1
5.	Analysis of LSD	1
6.	Analysis of factorial experiment	1
7.	Analysis of asymmetric factorial experiments	1
8.	Analysis of confounded factorial experiments	1
9.	Analysis with missing data in RBD	1
10.	Analysis with missing data in LSD	1
11.	Transformation of data	1
12.	Analysis of SPD	1
13.	Analysis of strip plot design	1
14.	Analysis of resolvable designs	1
15.	Fitting of response surfaces	2

References:

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

Objective

To impart basic knowledge about soil physical properties and processes in relation to plant growth.

Theory

Scope of soil physics and its relation with other branches of soil science; soil as a three phase system,soil texture, textural classes, mechanical analysis, specific surface, soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts, soil structure - genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation, soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential, water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils, infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum, composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management, modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

Practical

Mechanical analysis by pipette and international methods, determination of bulk density of soil by core sampler method, measurement of Atterberg limits, aggregate analysis - dry and wet, measurement of soil-water content by different methods, measurement of soil-water potential by using tensiometer and gypsum blocks, determination of soil-moisture characteristics curve and computation of pore-size distribution, determination of hydraulic conductivity under saturated and unsaturated conditions, determination of infiltration rate of soil, determination of aeration porosity and oxygen diffusion rate, soil temperature measurements , estimation of water balance components in bare and cropped fields.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Scope of soil physics and its relation with other branches of soil science, Soil as a three phase system	2
2.	Soil texture, textural classes, mechanical analysis, specific surface	2
3.	Soil consistence; dispersion and workability of soils	2
4.	Soil compaction and consolidation	2
5.	Soil strength; swelling and shrinkage - basic concepts	2
6	Soil structure - genesis, types, characterization and management soil structure	2
7	Soil aggregation, aggregate stability	1
8	Soil tilth, characteristics of good soil tilth	1
9	Soil crusting - mechanism, factors affecting and evaluation	1
10	Soil conditioners and Puddling, its effect on soil physical properties and clod formation.	2
11	Water flow in saturated soils	1
12	Water flow in unsaturated soils	1
13	Poiseuille's law and Darcy's law	1

14	Hydraulic conductivity and hydraulic diffusivity	1
15	Measurement of hydraulic conductivity in saturated and unsaturated soils.	1
16	Permeability and fluidity	1
17	Infiltration and Internal drainage and redistribution	1
18	Evaporation, hydrologic cycle, field water balance	2
19	Soil-plant-atmosphere continuum	1
20	Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management	2
21	Modes of energy transfer in soils	1
22	Energy balance; thermal properties of soil	1
23	Measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management	2

Lecture schedule—Practical

S. No.	Topic	No. of lecture
1.	Mechanical analysis by pipette and international methods	1
2.	Determination of bulk density of soil by core sampler method	1
3.	Measurement of Atterberg limits	1
4.	Aggregate analysis - dry and wet methods	1
5.	Measurement of soil-water content by different methods	1
6.	Measurement of soil-water potential by using tensiometer	1
7.	Measurement of soil-water potential by using gypsumblocks	1
8.	Determination of soil-moisture characteristics curve and computation of pore-size distribution	1
9.	Determination of hydraulic conductivity under saturated conditions	1
10.	Determination of hydraulic conductivity under unsaturated conditions	1
11.	Determination of infiltration rate of soil	1
12.	Determination of aeration porosity	1
13.	Determination of oxygen diffusion rate	1
14.	Soil temperature measurements	1
15.	Estimation of water balance components in bare fields	1
16.	Estimation of water balance components in e and cropped fields	1

Suggested Readings

Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.

Ghildyal BP &Tripathi RP. 2001. *Soil Physics.* New Age International.

Hanks JR & Ashcroft GL. 1980. *Applied Soil Physics*. Springer Verlag.

Hillel D. 1972. *Optimizing the Soil Physical Environment toward Greater Crop Yields*. Academic Press.

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

Hillel D. 1980. *Fundamentals of Soil Physics*. Academic Press.

Hillel D. 1998. *Environmental Soil Physi*cs. Academic Press.

Hillel D. 2003. *Introduction to Environmental Soil Physics*. Academic Press.

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Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley-Interscience.

Kohnke H. 1968. *Soil Physics*. McGraw Hill.

Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.

Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

Saha AK. 2004. *Text Book of Soil Physics*. Kalyani.

03MSOI102 Management of Problem Soils and Waters 3(2+1)

Objective

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible, morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties, management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils, acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management, quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality, agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical

Characterization of acid, acid sulfate, salt-affected and calcareous soils, determination of cations (Na+, K+, Ca++ and Mg++) in ground water and soil, samples, determination of anions (Cl-, SO4--, CO3-- and HCO3-) in ground waters and soil samples, lime requirements of acid soil and gypsum requirements of sodic soil.

Lecture schedule—Theory

S. No	Topic	No. of lecture
1.	Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils	2
2.	Origin and basic concept of problematic soils, and factors responsible	3
3.	Morphological features of saline, sodic and saline-sodic soils	2
4.	Characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties	2
5.	Management of salt-affected soils	2
6.	Salt tolerance of crops - mechanism and ratings	2
7.	Monitoring of soil salinity in the field	1
8.	Management principles for sandy, clayey, red lateritic and dry land soils	3
9.	Acid soils - nature of soil acidity, sources of soil acidity	1
10.	Soil acidity effect on plant growth and lime requirement of acid soils	2
11.	Management of acid and acid sulphate soils	2
12.	Biological sickness of soils and its management	2
13.	Quality of irrigation water and their crop response	2
14.	Management of brackish water for irrigation	2
15.	Salt balance under irrigation	1
16.	Characterization of brackish waters, area and extent, relationship in water use and quality	3

Lecture schedule – practical

S. No.	Topic	No. of

		lecture
1.	Characterization of acid and acid sulfate soils salt-affected and calcareous soils	1
2.	Characterization of salt-affected soils	1
3.	Characterization of calcareous soils	1
4.	Determination of Ca++ and Mg++ in soil	1
5.	Determination of Ca++ and Mg++ in ground water	1
6.	Determination of Potassium in ground water	1
7.	Determination of Potassium in soil	1
8.	Determination of sodium in ground water	1
9.	Determination of sodium in soil	1
10	Determination of CO3-- and HCO3- in ground waters	1
11	Determination of CO3-- and HCO3- in soil	1
12	Determination of chloride in ground waters	1
13	Determination of chloride soil	1
14	Determination of sulphate (SO4--) in ground waters	1
15	Determination of sulphate (SO4--) in soil	1
16	Determination of gypsum requirement of sodic soil	1
17	Determination of lime requirement of acid soil	1

Suggested Readings

Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.

Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.

USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline andAlkali Soils*. Oxford & IBH.

03MSOI103 Modern Concepts in Crop Production 3(3+0)

Objective

To teach the basic concepts of soil management and crop production.

Theory:

Agronomic aspects in food security; Crop growth and production in relation to climate change; Agro ecological andagroclimatic zones of India; Concept of potential yield; Modern concepts in tillage - zero, minimum and conservation tillage; Optimization of plant population and planting geometry in relation to soil fertility, solar radiation and available moisture regimes; Mitscherlich , Baule and Inverse yield : nitrogen laws; Biotic and abiotic stresses; Concept of ideal plant type; Organic farming, Physiology of grain yield in cereals; Crop growth analysis; Crop modelling in agronomic systems; Precision agriculture; Growth regulators and their role in agriculture; Designer crops; Vermi-technology; Agro biodiversity; Seed priming; ; Indigenous technological knowledge; Herbicide resistance in weeds; Allelopathy in agriculture ; Plant nutrition and disease tolerance in field crops.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Population and food requirement	1
2	Agronomic techniques for food security, crop nutrition, value addition	2
3	Effect of climate change on crop production	1
4	Direct and interactive effect of different climatic parameters on crop production	2
5	Agroecological and agroclimatic zones of India and their introduction	2
6	Concept of potential yield	1
7	Introduction to modern concepts of tillage - zero tillage minimum tillage, furrow irrigated raised bed system, resource conservation	3
8	Conservation tillage - its advantages, disadvantages , types and Methods	1
9	Relationship between plant population and yield and response curves	1
10	Optimum plant population in relation to soil fertility and solar radiation	1
11	Mitscherlich equation, Baule unit and inverse yield: nitrogen laws	2
12	Abiotic and biotic stresses	2
13	Definition and concept of ideal plant type	1
14	Characteristics of an ideotype plant for dryland agriculture	1
15	Ideotype plant for wheat	1
16	Organic farming – definition, differences between conventional and organic farming and principles and components of organic farming	2
17	Physiology of grain yield in cereals	2
18	Growth curves and analysis of crop growth : LAI, CGR, RGR, NAR, LAD	2
19	Crop model-definition, concept and types (empirical & mechanistic)	1
20	Scientific basis of modelling	1
21.	Model applications	1
22	Precision agriculture-definition, basic concept, scope and approach	1
23.	Technologies for precision agriculture: computers, geographical information system (GIS), global positioning, system (GPS), sensors, etc.	2
24.	Plant growth regulators-definition,types and their role in crop Production	2
25	Designer crops - concept and importance	2
26	Vermi- technology , meaning, methods and scope	2

27	Agro- biodiversity- definition, effects, threats and conservation	2
28	Seed priming- concept, importance and use in crop production	1
29	Indigenous technological knowledge and its use in crop production	1
30	Herbicide resistance in weeds – meaning and management of resistant weeds	2
31	Allelopathy in agriculture	1
32	Plant nutrition and disease tolerance in field crops	1

Suggested Readings:

1. Gardner, F.P.;Pearce, G.R. and Michell, R.I. Physiology of Crop Plants, Scientific Pub., Jodhpur.
2. S.P. Palaniappan and Shivarama,K. 1996. Cropping Systems in the Tropics - Principles and Management. New Age International Pub.
3. Fageria, N.K. 1992. Maximising crop yields. Marcel Dekker, New York.
4. Reddy,S.R. 2000. Principles of Agronomy. Kalyani Pub. New Delhi.
5. Sankaran, S. and Mudaliar ,T.V.S. l997. Principles of' Agronomy. The Bangalore Printing and Pub. Bangalore.
6. Redford, J. 1967. Growth Analysis formulae: Their use and abuse. Crop Science. 76:171 - 175.
7. Singh, G.; Kolar, J.S. and Sekhon, H.S. 2002 Recent Advances in Agronomy (Ed). ISA, Publication, New-Delhi.
8. Paroda, R.S. 2003. Sustaining Our Food Security. Konark Publishers Pvt. Ltd., Delhi
9. Balasubrammaniyan P. and Palaniappan, S.P. 2001. Principles and Practices of Agronomy. Agrobios
10. Havlin J.L., Beaton J.D., Tisdale S.L. and Nel son W.L. 2006. Soil Fertility and Fertilizers. 7th Ed. Prentice Hall.

Objective

To familiarize the students about the weeds, herbicides and methods of weed control.

Theory

Weed–biology, ecology and classification; history, development and classification of herbicides, their properties, mode of action and uses, basis of selectivity of herbicides; herbicide mixtures, adjuvants and safeners; weed control principles and management practices in important grain crops, oilseeds, pulses, sugar, fiber crops, tuber crops and forage crops; vegetables and orchards; weed control under specific situations viz. intercropping systems, non-cropped areas and drylands; noxious farm weeds and parasitic weeds and their control; fate of herbicides in soil; herbicide - pesticides and fertilizer interactions; allelopathic effect; integrated weed management; problem of aquatic weeds particularly water hyacinth, hydrilla and typha grass in Rajasthan and their possible control measures; weed control through bio herbicides and myco- herbicides; herbicide resistance in weeds and crops.

Practical :

Identification of common k*harif*, *rabi*and perennial weeds of crop fields, road sides, waste lands and irrigation channels; familiarization with trade names, common names, uses, cost and source of availability of herbicides; calibration of sprayer and maintenance (before and after use); study of different herbicidal formulations; calculation on herbicidal requirement for field crops and aquatic situation; application of herbicides in field crops; control of some noxious weeds by cultural and chemical means; study on weed control efficiency and calculation on weed infestation and weed index; preparation of weed herbarium, methodology for weed control research and precautions in handling or storage of herbicides.

Lecture schedule – Theory

S. No.	Topic	No. of lectures
1	Weeds- biology, ecology and classification	2
2	Herbicides -	2
	a) History, development and classification of herbicides	2
	b) Properties of herbicides	2
	c) Mode of action and uses of herbicides	2
	d) Basis of selectivity of herbicides	2
3	Herbicide mixtures, adjuvants and safeners	2
4	Weed control principles and management practices in important crops	1
	a) Grain crops	2
	b) Oilseeds and pulses	2
	c) Sugar and fibre crops	1
	d) Tuber and forage crops	2
	e) Vegetable crops	2
	f) Orchards	1
5	Weed control under specific situations – intercropping system, drylands and non cropped area	1
6	Noxious farm weeds, parasitic weeds and their control	1
7	Fate of herbicides in soil	2
8	Herbicide- pesticides and fertiliser interactions	1
9	Allelopathic effects	1
10	Integrated weed management	1
11	Problem of aquatic weeds particularly water hyacinth, hydrilla and typha grass in Rajasthan and their possible control measures	1

12	Weed control through bio-herbicides and myco- herbicides	1
13	Herbicide resistance in weeds and crops	1

Lecture schedule-Practical

S. No.	Topic	No. of lectures
1.	Identification of common Kharif and Rabi weeds	1
2.	Identification of perennial weeds of crop fields, road sides, wastelands and irrigation channels	1
3.	Familiarization with trade names, common names, uses, cost and sources of availability of herbicides	1
4.	Calibration of sprayers and maintenance (before and after use)	1
5.	Study of different herbicidal formulations	1
6.	Calculation on herbicidal requirement for field crops under aquatic situations	2
7.	Application of herbicides in field crops	2
8.	Control of some noxious weeds by cultural and chemical means	1
9.	Study on weed control efficiency and calculation on weed infestation and weed index	2
10.	Preparation of weed herbarium	2
11.	Methodology for weed control research	1
12.	Precautions in handling or storage of herbicides	1

Suggested Readings :

Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.
Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley Inter-Science. Gupta OP. 2007. *Weed Management – Principles and Practices.* Agrobios.
Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ. Rao VS. 2000. *Principles of Weed Science*. Oxford & IBH.
Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani. Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic. Press

BHAGWANT UNIVERSITY

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Sikar Road, Ajmer

RAJASTHAN

Syllabus

M.Sc. (Ag. Extension & Communication)

Faculty of Agriculture

Bhagwant University, Ajmer (Raj.)

M.Sc. (Ag.) Course Programs

AGRICULTURAL EXTENSION & COMMUNICATION

	Semester I		
BU Course No.	**Course No**	**Course Title**	**Credit Hours**
01MEXT101	**EXT 511**	Development Perspectives of Extension Education	**3(2+1)**
01MEXT102	**EXT 512**	Development Communication and Information Management	**3(2+1)**
01MEXT103	**EXT 513**	Diffusion and Adoption Of Innovations	**3(1+2)**
01MEXT104	**AGRON 511**	Agrometeorology and crop weather forecasting	**3(2+1)**
	Semester II		
02MEXT101	**EXT 521**	E-Extension	**3(2+1)**
02MEXT102	**EXT 522**	Entrepreneurship Development and Management In Extension	**3(2+1)**
02MEXT103	**EXT 523**	Human Resource Development	**3(2+1)**
02MEXT104	**EXT 524**	Participatory Methods For Technology Development and Transfer	**2(2+0)**
02MEXT105	**STAT 521**	Experimental design	**3(2+1)**
	Semester III		
03MEXT101	**EXT 531**	Research Methods In Behavioral Sciences	**3(2+1)**
03MEXT102	**EXT 532**	Visual Communication	**3(2+1)**
03MEXT103	**AGRON 521**	Modern concepts in crop production	**3(3+0)**
03MEXT104	**AGRON 522**	Principles and practices of weed management	**3(2+1)**
	Semester IV		
04MEXT101	**EXT 541**	M.Sc. Seminar	**1(0+1)**
04MEXT102	**EXT 542**	Comprehensive	**2(0+2)**
04MEXT103	**EXT 543**	M.Sc. Research	**15**

01MEXT101 Development Perspectives of Extension Education 3(2+1)

Objective

The course is intended to orient the students with the concept of extension education and its importance in Agriculture development and also to expose the students with various rural development programmes aimed at poverty alleviation and to increase employment opportunites and their analysis. Besides, the students will be learning about the new innovations being brought into the Agricultural Extension in India.

Theory

Extension Education – Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions – Extension Education as a Profession – Adult Education and Distance Education.Pioneering Extension efforts and their implications in Indian Agricultural Extension – Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University.Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development.Current Approaches in Extension: Decentralized Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centres, NAIP.

Practical

Visit to Gram Panchayat to study on-going Rural Development Programmes, Visit to KVK, NGO and Extension centers of State Agricultural University and State Departments, Bottom up planning, Report preparation and presentations.

Lecture schedule: Theory

S.No.	Topic	No. Of lectures
1.	Extension Education – meaning, objectives, concepts	2
2.	Extension Education - principles and philosophy	1
3.	Extension Education – critical analysis of definitions	1
4.	Extension Education as a Profession	1
5.	Adult Education and Distance Education	1
6.	Pioneering Extension efforts and their implications in Indian Agricultural Extension	2
7.	Analysis of Extension systems of ICAR and SAU	1
8.	State Departments Extension system and NGOs	2
9.	Role of Extension in Agricultural University.	1
10.	Poverty Alleviation Programmes – SGSY, SGRY	2
11.	Poverty Alleviation Programmes – PMGSY, DPAP, DDP, CAPART	2
12.	Employment Generation Programmes – NREGP	2
13.	Women Development Programmes – ICDS, MSY, RMK	2
14.	Problems in Rural Development.	2
15.	Current Approaches in Extension	2
16.	Decentralized Decision Making, Bottom up Planning	1
17.	Farming System Approach, Farming Situation Based Extension	2
18.	Market – Led – Extension	2
19.	Farm Field School	1
20.	ATIC	1
21	Kisan Call Centres, NAIP	1

Lecture schedule :Practical

S.No.	Topic	No. Of lectures
1.	Visit to Gram Panchayat to study on-going Rural Development Programmes	2
2.	Visit to KVK	3
3.	Visit to NGO	2
4.	Visit to Extension centers of State Agricultural University	3
5.	Visit to State Departments	3
6.	Bottom up planning	1
7.	Report preparation	1
8.	Report presentations.	1

Suggested Readings

Chandrakandan KM, Senthil Kumar & Swatilaxmi. PS**.** 2005. *Extension Education What? And What Not ?* RBSA Publ.

Gallagher K. 1999. *Farmers Field School (FFS)–A Group Extension Process based on Non-Formal EducationMethods*. Global EPM Facility, FAO.

Ganesan R, Iqbal IM & Anandaraja N. 2003. *Reaching the Unreached: Basics of Extension Education.* Associated Publishing Co.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension*. Concept Publ.

Khan PM. 2002. *Textbook of Extension Education.* Himalaya Publ.

Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ. Van Den Ban AW & Hawkins HS. 1998. *Agricultural Extension* .2nd Ed. CBS.

Viswanathan M. 1994. *Women in Agriculture and Rural Development*. Printwell Publ.

01MEXT102 Development Communication And Information Management 3(2+1)

Objective

In this course, students will learn about the concept, meaning and process of communication and various methods and modern media of communication. Besides, the students will also learn the information management and journalistic writing of various information materials and also study their readability.

Theory

Communication process – concept, elements and their characteristics – Models and theories of communication – Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication – Barriers in communication, Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message. Methods of communication – Meaning and functions, classification. Forms of communication – Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication. Key communicators – Meaning, characteristics and their role in development.Media in communication – Role of mass media in dissemination of farm technology, Effect of media mix for Rural People. Modern communication media – Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications. Agricultural Journalism as a means of mass communication, Its form and role in rural development, Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders. Techniques of collection of materials for news stories and feature articles; Rewriting Art of clear writing, Readability and comprehension testing procedures; photo journalism, communicating with pictures, Radio and TV Journalism, Techniques of writing scripts for Radio and TV.

Practical

Writing News for Farm News paper/Magazines. Reporting of Various Extension activities like-Field day, Training, Result Demonstration and farmer' fair etc. Preparing and delivering effective speech. Handling of communication and recording equipments (like-Computer, P.A.System & Camera). Script writing for Radio, T.V. Conducting students' visit to Radio & T.V. station

Lecture schedule: Theory

S.No.	Topic	No. of Lectures
1	Communication process – concept, elements and their characteristics	2
2	Models and theories of communication	1
3	Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks	3
4	Development communication – Barriers in communication	1
5	Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.	1
6	Methods of communication – Meaning and functions, classification	2
7	Forms of communication – Oral and written communication	1
8	Non-verbal communication, interpersonal communication, organizational communication. Key communicators	2
9	Meaning, characteristics and their role in development.	1
10	Media in communication – Role of mass media in dissemination of farm technology	2
11	Effect of media mix for Rural People. Modern communication media	2
12	Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications.	2
13	Agricultural Journalism as a means of mass communication, Its form and role in rural development	2
14	Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders	2
15	Techniques of collection of materials for news stories and feature articles	2
16	Rewriting Art of clear writing, Readability and comprehension testing procedures	2
17	Photo journalism, communicating with pictures.	2
18	Radio and TV Journalism, Techniques of writing scripts for Radio and TV.	2
	Total	32

Lecture schedule :Practical

S. No.	Topic	No. Of Lectures
1.	Writing News for Farm News paper/Magazines	2
2.	Reporting of Various Extension activities like-Field day, Training, Result Demonstration and farmer' fair etc.	3
3.	Preparing and delivering effective speech.	2
4.	Handling of communication and recording equipments (like-Computer, P.A.System & Camera).	3
5.	Script writing for Radio	2
6.	Script writing for T.V.	2
7.	Conducting students' visit to Radio & T.V. station	2
	Total	**16**

Suggested Readings

Dahama OP & Bhatnagar OP. 2005. *Education and Communication for Development.* Oxford & IBH.

Grover I, Kaushik S, Yadav L & Varma SK. 2002. *Communication and Instructional Technology*. Agrotech Publ. Academy.

Jana BL & Mitra KP. 2005. *Farm Journalism.* Agrotech Publ. Academy.

Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ.

Rayudu CS.2002. *Communication.* Himalaya Publ. House.

Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.

Sandhu AS. 2004. *Textbook on Agricultural Communication Process and Methods*. Oxford & IBH.

01MEXT103 Diffusion and Adoption of Innovations 3(2+1)

Objective

The students will learn how the agricultural innovations spread among the farmers in the society by getting into the insights of diffusion concept and adoption process, stages of adoption and innovation decision process, adopter categories and their characteristics, opinion leaders and their characteristics, attributes of innovations, and factors influencing adoption.In addition, the students would be learning various concepts related to diffusion and adoption of innovations.

Theory

Diffusion – concept and meaning, elements; traditions of research on diffusion; the generation of innovations; innovation-development process; tracing the innovation-development process, converting research into practice. The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process – a critical appraisal of the new formulation. Adopter categories – Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption. Diffusion effect and concept of over adoption, o pinion leadership- measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations; Types of innovation-decisions – Optional, Collective and Authority and contingent innovation decisions; Consequences of Innovation-Decisions – Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making – meaning, theories, process, steps, factors influencing decision – making.

Practical

Case studies in individual and community adoption process, content analysis ofadoption studies, Identification of adopter categories on a selected technology, study of attributes of current farm technologies, Identification of opinion leaders, Sources of information at different stages of adoption on a selected technology, study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.

Lecture schedule: Theory

S.No.	Topic	No. Of Lectures
1.	Diffusion – concept and meaning, elements, traditions of research on diffusion	2
2.	The generation of innovations; innovation-development process; tracing the	2
3.	innovation- development process, converting research into practice. The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages	3
4.	The innovation-decision process – a critical appraisal of the new formulation.	2
5.	Adopter categories – Innovativeness and adopter categories	1
6.	Adopter categories as ideal types, characteristics of adopter categories	2
7.	Perceived attributes of Innovation and their rate of adoption	2
8.	Factors influencing rate of adoption.	2
9.	Diffusion effect and concept of over adoption	2
10.	Opinion leadership- measurement and characteristics of opinion leaders	2
11.	Monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations	3
12.	Types of innovation-decisions – Optional, Collective and Authority and contingent innovation decisions	3
13.	Consequences of Innovation-Decisions	2
14.	Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences	2
15.	Decision making – meaning, theories, process, steps, factors influencing decision – making.	2

Lecture schedule :Practical		
S. No.	**Topic**	**No. of lectures**
1.	Case studies in individual and community adoption process	
2.	Content analysis of adoption studies	
3.	Identification of adopter categories on a selected technology	2
4.	Study of attributes of current farm technologies	2
5.	Identification of opinion leaders	2
6.	Sources of information at different stages of adoption on a selected technology	2
7.	Study of factors increasing or retarding the rate of adoption	2
8.	Presentation of reports on adoption and diffusion of innovations.	2

Suggested Readings

Dasgupta. 1989. *Diffusion Agricultural Innovations in Village India*. Wiley Eastern.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension.* Concept Publ. Co.

Ray GL. 2005. *Extension Communication and Management*. Kalyani Publ.

Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.

Rogers EM. 2003. Diffusion of Innovations. 5th Ed. The Free Press, NewYork.

01MEXT104 Agrometeorology and Crop Weather Forecasting 3(2+1)

Objective

To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

Theory:

Agro meteorology: aim, scope and development in relation to crop environment, composition of atmosphere, distribution of atmospheric pressure, Solar radiation : characteristics, energy balance of atmosphere system, radiation distribution in plant canopies, radiation utilization by field crops, photosynthesis and efficiency of radiation utilization by crops, energy budget of plant canopies, Environmental temperature: soil, air, canopy temperature, temperature profile in air, soil and crop canopies, soil and air temperature effects on plant processes, regulation of air, soil temperature for protection against frost and hot winds, Environmental moisture and evaporation, measures of atmospheric moisture, temperature, relative humidity, vapour pressure and their relationship, evapotranspiration and meteorological factors determining evapotranspiration, Modification of plant environment: artificial rain making, controlling heat load, heat trapping and shedding, protection from cold, reduction in sensible and latent heat flux, Monsoon: monsoon and their origin, characteristics of monsoon, onset and progress of monsoon, withdrawal of monsoon, Weather forecasting in India: short, medium and long range forecasting, benefits of weather service to agriculture, forecasting of destructive frost, soil moisture forecast, phenological forecast, crop yield forecast, Aero-space science and remote sensing : application in agriculture, present status of remote sensing in India, Atmospheric pollution and its effect on climate and crop production.

Practical

Agrometeorological observatory- classes, site selection, layout and installation of meteorological instruments; handling of meteorological instruments; measurement of weather parameters; working out agroclimatic indices; maintenances of record; calculation of daily, weekly and monthly means; visit to state remote sensing centre, Jodhpur/Jaipur; measurement of soil temperature in different soil conditions/depths; interpretation and use of weather data; rainfall analysis for variability; moisture availability indices for an arid and a humid district, length of growing season, fitting cropping systems; preparation of weathe r maps, synoptic charts and weather reports; preparation of crop weather calendars, to become familiar with agro advisory service bulletins visit to ARS, Durgapura/Bikaner.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Agro meteorology - aim, scope and development in relation to crop environment	2
2	Composition of atmosphere, distribution of atm. pressure	1
3	Solar radiation - characteristics	1
4	Energy balance of atmosphere system	1
5	Radiation distribution in plant canopies, radiation utilization by field crops	2
6	Photosynthesis and efficiency of radiation utilization by crops	2
7	Energy budget of plant canopies	1
8	Environmental temperature- soil, air, canopy temperature, temperature profile in air, soil, crop canopies	2
9	soil and air temperature effects on plant processes	2
10	Regulation of air, soil temperature for protection against frost and hot winds	2
11	Environmental moisture and evaporation - measures of atmospheric moisture, temperature, relative humidity, vapour pressure and their relationship	2
12	Evapotranspiration and meteorological factors determining evapotranspiration	2
13	Modification of plant environment, artificial rain making, controlling heat load, heat trapping and shedding	2
14	Protection from cold, reduction in sensible and latent heat flux	1
15	Monsoon and their origin, characteristics of monsoon	1
16	Onset and progress of monsoon withdrawal of monsoon	1
17	Weather forecasting in India: short, medium and long range forecasting	2
18	Benefits of weather service to agriculture, forecasting of destructive frost, soil moisture forecast, phenological forecast, crop yield forecast etc	2

19	Aero-space science and remote sensing - application in agriculture, present status of remote sensing in India.	2
20	Atmospheric pollution and its effect on climate and crop production	1

Lecture schedule- Practical

S. No.	Topic	No. of lectures
1	Agro meteorological observatory – classes, site selection, layout and installation procedures for meteorological instruments	1
2	Handling of meteorological instruments	1
3	Measurement of weather parameters	1
4	Working out agro climatic indices	1
5	Maintenance of records	1
6	Calculation of daily, weekly and monthly means	2
7	Visit to state Remote Sensing Centre, Jodhpur/Jaipur	1
8	Measurement of soil temperature in different soil conditions/depths	1
9	Interpretation and use of weather data	1
10	Rainfall analysis for variability	2
11	Moisture availability indices for an arid district	1
12	Moisture availability indices for a humid district	1
13	Length for growing season, fitting cropping systems	1
14	Preparation of weather maps, synoptic charts & weather reports	1
15	Preparation of crop weather calendar	1
16	To become familiar with Agro-advisory-service bulletins/	1

Suggested Readings:

S. Mavi (1994). Introduction to Agrometeorology. Oxford & IBH Publishing Co. New Delhi.

P.A. Menon (1989). Our weather. National Book Trust, New Delhi.

A.C. Rama Sastu (1984). Weather and Weather forecasting Publication Division, GOI. P.K. Das (1992). The Monsoon. National Book Trust, New Delhi.

S. Venkateraman and A. Krishnan. Crops and Weather. Indian Council of Agricultural Research, New Delhi.

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R.S. Gena and S.P. Seetharaman (1991). Natural Resource Management: The Role of Remote sensing in decision making. Oxford & IBH Publishing Co. New Delhi.

K.L. Joshi, Sinha and D.P. Gupta (1985). Physical Geography, National Council of Educational Research and Training, New Delhi.

Vasiraju Radha Krishna Murthy (1995). Practical Manual on Agricultural Meteorology, Kalyani Publishers, Ludhiana.

D.S. Lal, 1998. Climatology. Sharda Pustak Bhawan.

S.R. Ghadekar, 1991. Meteorology, Agromet Publishers, Nagpur.

A.K. Sacheti, 1985. Agricultural Meteorology- Instructional-cum-Practical Manual. NCERT, New Delhi. Mavi H.S. and Tuper G.J. 2004. Agrometeorology: Principles and Application of Climate Studies in Agriculture. Haworth Press.

Vashneya M.C. and Balakrishana Pillai P. 2003. Textbook of Agricultural Meteorology, ICAR.

02MEXT101 Extension 3(2+1)

Objective

Students will gain knowledge and skills in understanding the concepts of Information and communication technologies and how these ICT tools can be used for Agricultural Extension. Besides, he studies various ICT projects which are successful in delivering the services to the clientele fulfilling the objective of Transfer of Technology i.e. Reaching the unreached.

Theory

ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities. ICTs projects, case studies in India and developing world. Different approaches (models) to ICTs. ICT use in field of extension- Expert systems on selected crops and enterprises; Self learning CDs on package of practices, diseases and pest management, Agricultural web sites and portals related crop production and marketing etc. Community Radio, Web, Tele, and Video conferencing. Computer Aided Extension. Knowledge management, Information kiosks, Multimedia. Online, Offline Extension. Tools-Mobile technologies, e-learning concepts. ICT Extension approaches-pre-requisites, information and science needs of farming community. Need integration. Human resource information. Intermediaries. Basic e-extension training issues. ICT enabled extension pluralism. Emerging issues in ICT.

Practical

Agril.content analysis of ICT Projects. Handling of ICT tools. Designing extension content. Online extension service. Project work on ICT enabled extension. Creation of extension blogs. Visit to ICT extension projects.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
3	Advantages, limitations and opportunities.	1
6	ICT use in field of extension	2
7	Expert systems on selected crops and enterprises	1
8	Self-learning CDs on package of practices, diseases and pest management	2
9	Agricultural web sites and portals related crop production and marketing etc	2
10	Community Radio, Web, Tele, and Video conferencing.	2
11	Computer Aided Extension	2
12	Knowledge management	1
13	Information kiosks,	2
14	Multimedia.	1
15	Online, Offline Extension. Tools	1
16	Mobile technologies	1
17	e-learning concepts.	1
18	ICT Extension approaches-pre-requisites,	1
19	information and science needs of farming community.	1
20	Need integration	1
21	Human resource information Intermediaries	1
22	Basic e-extension training issues.	1
23	ICT enabled extension pluralism.	1
24	Emerging issues in ICT	1

Lecture schedule- Practical

S. No.	Topic	No. of lectures
1	Agril. content analysis of ICT Projects.	2
2	Handling of ICT tools.	2
3	Designing extension content.	2
4	Online extension service.	2
5	Project work on ICT enabled extension.	3
6	Creation of extension blogs.	2
7	Visit to ICT extension projects	3

Suggested Readings

Batnakar S & Schware R. 2000. *Information and Communication Technology in Development- Cases from India.*

Sage Publ.
Meera SN. 2008. *ICTs in Agricultural Extension: Tactical to Practical*.
Ganga-Kaveri Publ. House. JangamWadiMath, Varanasi.
Willem Zip. 1994. *Improving the Transfer and Use of Agricultural Information - A Guide to Information Technology*.
The World Bank, Washingto

02MEXT102 Entrepreneurship Development and Management in Extension 3(2+1)

Objective

The first part of the course is intended to provide overall picture of planning and development of enterprises for extending sustainable livelihoods for rural people. The second part of the course is structured to help the students to gain knowledge and skills in different concepts and techniques of management in extension organizations.

Theory

Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development. Agri – entrepreneurship – Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs – Risk taking, Leadership, Decision making, Planning, Organising, Coordinating and Marketing, Types of Entrepreneurs. Stages of establishing enterprise – Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects. Management – Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Making planning effective. Change Management – factors, process and procedures. Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions. Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations. Coordination – Concept, Need, Types, Techniques of Coordination. Interpersonal relations in the organization. Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods. Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles. Organizational Communication – Concept, Process, Types, Net Works, Barriers to Communication. Managing work motivation – Concept, Motivation and Performance, Approaches to motivation.

Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision.

Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.

Practical

Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs Development of Project Proposal -Case Studies of Success / Failure enterprises-Exercise on Market Survey-Field visit to Financial institutions-Simulated exercise to understand management process-Field visit to extension organizations to understand the functions of management -Group exercise on development of short term and long term plan-Simulated exercise on techniques of decision making-Designing organizational structure -Group activity on leadership development skills.

Lecture schedule- Theory

S.No.	Topic	No. of lectures
1.	Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development.	2
2.	Agri – entrepreneurship – Concept, characteristics, Nature and importance for sustainable Livelihoods.	1
3.	Traits of entrepreneurs – Risk taking, Leadership, Decision making, Planning, Organising, Coordinating and Marketing	2
4.	Types of Entrepreneurs. Stages of establishing enterprise – Identification of sound enterprise	2
5.	Steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements.	2
6.	Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects.	2

7.	Management – Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager.	2
8.	Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Making planning effective.	2
9.	Change Management – factors, process and procedures. Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions.	2
10.	Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations.	2
11.	Coordination – Concept, Need, Types, Techniques of Coordination. Interpersonal relations in the organization.	1
12.	Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods.	2
13.	Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction.	2
14.	Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles.	2
15.	Organizational Communication – Concept, Process, Types, Net Works, Barriers to Communication.	2
16.	Managing work motivation – Concept, Motivation and Performance, Approaches to motivation. Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision.	2
17.	Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.	2

Lecture schedule- Practical		
Topic No. of lectures		
1.	Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs	2
2.	Development of Project Proposal	2
3.	Case Studies of Success / Failure enterprises-Exercise on Market Survey	2
4.	Field visit to Financial institutions-Simulated exercise to understand management process	2
5.	Field visit to extension organizations to understand the functions of management	2
6.	Group exercise on development of short term and long term plan	2
7.	Simulated exercise on techniques of decision making	2
8.	Designing organizational structure -Group activity on leadership development skills.	2

Suggested Readings

Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand & Sons.
Indu Grover. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public Academy.
Khanka SS. 1999. *Entrepreneurial Development*. S. Chand & Co.
Singh D. 1995. *Effective Managerial Leadership*. Deep & Deep Publ.
Tripathi PC & Reddy PN. 1991. *Principles of Management*. Tata McGraw Hill.
Vasanta Desai. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.

02MEXT103 Human Resource Development 3(2+1)

Objective

To orient the students about key concepts importance, scope & conceptual frame work, growth & development of Human Resource Development, Subsystems of Human Resource Development for extension organization and process of HRD.

Theory

Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions – Different Experiences; Selection, Development & Growth- Selection, Recruitment, Induction Staff Training and Development, Career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure, society in transition; Organizational and Managerial values and ethics, organizational commitment ; Motivation productivity -job description – analysis and evaluation; Performance Appraisal. Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): What is HRA? Why HRA? Information Management for HRA and Measurement in HRA; Intra personal processes: Collective behaviour, learning, and perception ; Stress and coping mechanisms; Inter-Personal Process, Helping Process – communication and Feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning, Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counseling and Mentoring; Role of a Professional Manager: Task of Professional Manager – Responsibility of Professional Manager; Managerial skills and Soft Stills required for Extension workers; Decision Making: Decision Making models, Management by Objectives; Behavioural Dynamics : Leadership styles – Group dynamics. Training – Meaning, determining training need and development strategies – Training types, models, methods and evaluation; Facilities for training – Trainers training – techniques for trainees participation; Research studies in training extension personnel; Main issues in HRD: HRD culture and climate – organizing for HRD – emerging trends and Prospective.

Practical

Visit to different training organizations to review ongoing activities & facilities; Analysis of Training methods followed by training institutions for farmers and extension workers Studies on evaluation of training programmes; Study of HRD in organization in terms of performance, organizational development, employees welfare and improving quality of work life and human resource information, Presentation of reports.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1.	Human Resource Development – Definition andMeaning	1
2.	Importance, Scope and Need for HRD	1
3.	Conceptual frame work, inter disciplinary approach, function systems of HRD	1
4.	Case studies in HRD	1
5.	HRD Interventions – Different Experiences of HRD	1
6.	Selection, Development & Growth for HRD	1
7.	Selection, Recruitment for HRD, Induction Staff Training and Development for HRD	1
8.	Career planning for HRD	1
9.	Social and Organizational Culture for HRD	1
10.	Indian environment perspective on cultural process and social structure, society in transition for HRD	1
11.	Organizational and Managerial values and ethics for HRD	1
12.	Organizational commitment for HRD	1
13.	Motivation productivity and job description for HRD	1
14.	Analysis and evaluation- Performance Appraisal for HRD	1
15.	Human Resource management- definition and meaning	1
16.	Collective bargaining and Negotiation skills	1
17.	Human Resource Accounting (HRA): What is HRA? Why HRA?	1
18.	Information Management for HRA and Measurement in HRA	1
19.	Intra personal processes: Collective behaviour, learning, and perception	1
20.	Stress and coping mechanisms	1

21.	Inter-Personal Process, Helping Process ,communication process, Feedback and interpersonal styles	1
22.	Group & Intergroup process: group information and group processes	1
23.	Organizational communication, Team building Process and functioning	1
24.	Conflict management, Collaboration and Competition	1
25.	HRD & Supervisors: Task Analysis	1
26.	Capacity Building – Counseling and Mentoring	1
27.	Role of a Professional Manager: Task of Professional Manager, Responsibility of Professional Manager	1
28.	Managerial skills and Soft Skills required for Extension workers	1
29.	Decision Making: Decision Making models	1
30.	Management by Objectives	1
31.	Behavioural Dynamics :Leadership styles and Group dynamics	1
32.	Training – Meaning, determining training need and development strategies	1
33.	Training types and models of trainings	1
34.	Methods of trainings	1
35.	Evaluation of trainings and Facilities for training (physical facilities)	1
36.	Trainers training – techniques for trainees participation	1
37.	Research studies in training for extension personnel	1
38.	Main issues in HRD, HRD culture and HRD climate, organizing training for HRD , emerging trends and Prospective for HRD	1

Lecture schedule- Practical

S. No.	Topic	No. of lectures
1.	Visit to different training organizations and to review on going activities & facilities	4
2.	Analysis of Training methods followed by training institutions for farmers and extension workers	4
3.	Studies on evaluation of training programmes organized by training institutions for farmers and extension workers	2
4.	Study of HRD in organization in terms of performance	2
5.	Organizational development, employees welfare and improving quality of work life	2
6.	Study of HRD information and presentation of reports	2

Suggested Readings

Agochiya D. 2002. *Every Trainer'sHandbook.* Sage Publ.

David Gross. 1997. *Human Resource Management - The Basics*. TR Publ.

Davis Keth & Newston W John 1989. Human Behaviour at Work. 8th Ed. McGraw-Hill.

Hersey Paul & Balanchard H Kenneth. 1992. *Management of Organizational Behaviour Utilizing Human Resource*. 5th Ed. Prentice-Hall of India.

Knoontz Harold & Weihhrich Heinz 1990. *Essentials of Management*. 5th Ed. McGraw-Hill.

Lynton RP & Pareek U. 1993. *Training for Development*. DB. Taraporewale Sons & Co.

Punna Rao P & Sudarshan Reddy M. 2001. *Human Resource Development Mechanisms for Extension Organization*.Kalyani Publ.

Rao TV. 2003. *Readings in Human Resource Development*. Oxford Publ. Co.

Silberman Mel. 1995. *Active Training.* Press Johnston Publ. Co., New Delhi.

Singh RP. 2000. *Management of Training Programmes.* Anmol Publ.

Subba Rao P. 2005. *Management & Organizational Behaviour*. Himalaya Publ. House.

Sundaram RM, Gupta V, George SS. 2006. *Case Studies in Human Resource Management*. ICFAI, Hyderabad.

Tripati & Reddy. 2004. *Principles of Management*. Tata McGraw-Hill.

Wayne MR & Robert MN. 2005. *Human Resource Management*. International Ed. Pearson Prentice Hall.

02MEXT104 Participatory Methods for Technology Development and Transfer 3(2+1)

Objective

This course is intended to orient the students with the key concepts, principles process of different participatory approaches for technology development and transfer and also to expose the students with various participatory tools and techniques like space related, time related, relation oriented methods. Besides the students will be learning the preparation of action plans participatory monitoring and evaluation.

Theory

Participatory extension – Importance, key features, principles and process of participatory approaches; Different participatory approaches (RRA, PRA, PLA, AEA, PALM, PAR, PAME, ESRE, FPR) and successful models. Participatory tools and techniques. Space Related Methods : village map (social & resource), mobility services and opportunities map and transect; Time related methods : time line, trend analysis, seasonal diagram. Daily activity schedule, dream map; Relation oriented methods : cause and effect diagram (problem tree), impact – diagram, well being ranking method, Venn diagram, matrix ranking, livelihood analysis. Preparation of action plans, concept and action plan preparation; Participatory technology development and dissemination; Participatory planning and management, phases and steps in planning and implementation aspects; Process monitoring, participatory evaluation.

Practical

Simulated exercises on space related methods, time related method and relation oriented methods; Documentation of PTD and dissemination; Preparation of action plan; Participatory monitoring and evaluation of developmental programmes.

Lecture schedule :Theory

S. No.	Topic	No. of lectures
1.	Participatory extension – Importance, key features	1
2.	Principles and process of participatory approaches	2
3.	Different participatory approaches (RRA,PRA, PLA) and successful models.	3
4.	Different participatory approaches (AEA, PALM, PAR,) and successful models.	3
5.	Different participatory approaches (PAME, ESRE, FPR) and successful models.	3
6.	Participatory tools and techniques. Space Related Methods : village map(social & resource), mobility services and opportunities map and transect.	4
7.	Participatory tools and techniques. Time related methods : time line, trend analysis, seasonal diagram. Daily activity schedule, dream map.	4
8.	Participatory tools and techniques. Relation oriented methods : cause and effect diagram (problem tree), impact – diagram, well being ranking method, Venn diagram, matrix ranking, livelihood analysis.	4
9.	Preparation of action plans, concept and action plan preparation.	2
10.	Participatory technology development and dissemination.	2
11.	Participatory planning and management, phases and steps in planning and implementation aspects.	2
12.	Process monitoring, participatory evaluation.	2

Lecture schedule: Practical

S.No.	Topic	No. of lectures
1.	Simulated exercises on village map(social & resource)	
2.	Simulated exercises on mobility services	
3.	Simulated exercises on opportunities map	
4.	Simulated exercises on transect walk	
5.	Simulated exercises on time line	
6.	Simulated exercises on trend analysis	
7.	Simulated exercises on seasonal diagram	
8.	Simulated exercises on Daily activity schedule	
9.	Simulated exercises on dream map	
10.	Simulated exercises on cause and effect diagram (problem tree)	
11.	Simulated exercises on impact – diagram	
12.	Simulated exercises on well being ranking method	
13.	Simulated exercises on Venn diagram	
14.	Simulated exercises on matrix ranking	

15.	Simulated exercises on livelihood analysis	
16.	Preparation of action plans	
17.	Participatory monitoring of developmental programmes	
18.	participatory evaluation of developmental programmes	

Suggested Readings

Adhikary. 2006. *Participatory Planning and Project Management in Extension Science*. Agrotech Publ. Academy.

02MEXT105 Experimental Designs 3(2+1)

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. 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

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control, Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design, Factorial experiments, (symmetrical as well as asymmetrical), orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment, 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, resolvable designs and their applications ~ concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures. **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; Analysis of resolvable designs; Fitting of response surfaces.

Lecture schedule: Theory

S. No.	Topics	No. of Lectures
1.	Basic concepts of design of experiment	2
2.	Basic principles of designs	3
3.	Uniformity trials	1
4.	Size and shape of plots and blocks	1
5.	Analysis of variance and transformations	2
6.	CRD, RBD and LSD	3
7.	Factorial experiments	4
8.	Confounding in symmetrical factorial experiments	2
9.	Factorial experiments with control treatment	2
10.	Split plot design	2
11.	Strip plot design	2
12.	Analysis of covariance and missing plot techniques	2
13.	crossover designs	1
14.	resolvable designs	1

15.	Response surfaces	2
16.	Experiments with mixtures	2

Lecture schedule: Practical

S. N.	Topics	No. of Lectures
1.	Formation of plots	1
2.	Formation of blocks	1
3.	Analysis of CRD	1
4.	Analysis of RBD	1
5.	Analysis of LSD	1
6.	Analysis of factorial experiment	1
7.	Analysis of asymmetric factorial experiments	1
8.	Analysis of confounded factorial experiments	1
9.	Analysis with missing data in RBD	1
10.	Analysis with missing data in LSD	1
11.	Transformation of data	1
12.	Analysis of SPD	1
13.	Analysis of strip plot design	1
14.	Analysis of resolvable designs	1
15.	Fitting of response surfaces	2

References:

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 Publ.

Pearce SC. 1983. *The Agricultural Field Experiment: A Statistical Examination of Theory and Practice*. John Wiley.

Design Resources Server: www.iasri.res.in/design.

03MEXT101 Research Methods inBehavioral Science 3(2+1)

Objective

This course is designed with a view to provide knowledge and skills in methods of behavioural sciences research and student will learn the appropriate statistics for data analysis.

Theory

Research – Meaning, importance, characteristics. Behavioural sciences research – Meaning, concept and problems in behavioural sciences research. Types and methods of Research – Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study. Review of literature – Need, Search Procedure, Sources of literature, Planning the review work. Research problem – Selection and Formulation of research problem and guiding principles in the choice of research problem, Factors and criteria in selection of research problem, statement of research problem and development of theoretical orientation of the research problem. Objectives – Meaning, types and criteria for judging the objectives. Concept and Construct – Meaning, role of concepts in research and Conceptual frame work development in research. Variable – Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, types and their role in research. Hypothesis – Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis. Measurement – Meaning, postulates and levels of measurement, Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research. Validity – Meaning and methods of testing. Reliability – Meaning and methods of testing. Sampling – Universe, Sample and Sampling-Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors – Methods of elimination and minimizing, Maximincon Principle, Sampling – Types of sampling and sampling procedures. Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of each design. Experimental design – Advantages and limitations. Data Collection devices - Interview – Meaning, purpose, types, techniques of interviewing and advantages and limitations. Enquiry forms and Schedules – Meaning, types of questions used, steps in construction and advantages and limitations in its use. Questionnaires – Meaning, difference between schedule and questionnaire, types of questions to be used, pre – testing of the questionnaires or schedules and advantages and limitations. Check lists – Meaning, steps in construction, advantages and limitations in its use. Rating scales – Meaning, types, limits in construction, advantages and limitations in its use. Observation – Meaning, types, tips in observation, advantages and limitations in its use. Case studies – Meaning, types, steps in conducting, advantages and limitations in its use. Social survey – Meaning, objectives, types and steps in conducting, advantages and limitations. Data processing – Meaning, coding, preparation of master code sheet, analysis and tabulation of data, choosing appropriate statistics for data analysis based on the level of measurement of variables. Report writing – Meaning, guidelines to be followed in scientific report writing, References in reporting.

Practical

Selection and formulation of research problem - Formulation of objectives and hypothesis-Selection of variables based on objectives-Developing the conceptual framework of research. Operationally defining the selected variables-Development of data collection devices.-Testing the validity and reliability of the data collection instruments.- Pre-testing of the data collection instrument-Techniques of interviewing and collection of data using the data collection instruments-Data processing, coding, tabulation and analysis. Formulation of secondary tables based on objectives of research. Writing report, Writing of thesis and research articles-Presentation of reports.

Lecture schedule: Theory

S.No.	Topic	No. of lectures
1.	Research – Meaning, importance, characteristics.	1
2.	Behavioural sciences research – Meaning, concept and problems in behavioural sciences research.	1
3.	Types and methods of Research – Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study.	2
4.	Review of literature – Need, Search Procedure, Sources of literature, Planning the review work.	1
5.	Research problem – Selection and Formulation of research problem and guiding principles in the choice of research problem	1
6.	Factors and criteria in selection of research problem, statement of research problem and development of theoretical orientation of the research problem.	1
7.	Objectives – Meaning, types and criteria for judging the objectives.	1
8.	Concept and Construct – Meaning, role of concepts in research and Conceptual frame work development in research.	1
9.	Variable – Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, types and their role in research.	2
10.	Hypothesis – Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis.	2
11.	Measurement – Meaning, postulates and levels of measurement, Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research.	2
12.	Validity – Meaning and methods of testing. Reliability – Meaning and methods of testing.	1
13.	Sampling – Universe, Sample and Sampling-Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors	1
14.	Methods of elimination and minimizing, Maximincon Principle, Sampling – Types of sampling and sampling procedures.	2
15.	Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of each design. Experimental design – Advantages and limitations.	2
16.	Data Collection devices - Interview – Meaning, purpose, types, techniques of interviewing and advantages and limitations.	2
17.	Enquiry forms and Schedules – Meaning, types of questions used, steps in construction and advantages and limitations in its use.	1
18.	Question –Meaning, difference between schedule and questionnaire ,type of question to be used , pre –testing of the questionnaires or schedules and advantage and limitation	1
19.	Check lists – Meaning, steps in construction, advantages and limitations in its use.	1
20.	Rating scales – Meaning, types, limits in construction, advantages and limitations in its use.	1
21	Observation – Meaning, types, tips in observation, advantages and limitations in its use.	1
22.	Case studies – Meaning, types, steps in conducting, advantages and limitations in its use	1
23	Social survey – Meaning, objectives, types and steps in conducting, advantages and limitations.	1
24.	Data processing – Meaning, coding, preparation of master code sheet, analysis and tabulation of data, choosing appropriate statistics for data analysis based on the level ofmeasurement of variables.	1
25.	Report writing – Meaning, guidelines to be followed in scientific report writing, References in reporting.	1

Lecture schedule : Practical		
S.No.	**Topic**	**No. of Lectures**
1.	Selection and formulation of research problem - Formulation of objectives and hypothesis	2
2.	Selection of variables based on objectives-Developing the conceptual framework of research	2
3.	Operationally defining the selected variables-Development of data collection devices.- Testing the validity	2
4.	Reliability of the data collection instruments.- Pre-testing of the data collection instrument-	2
5.	Techniques of interviewing and collection of data using the data collection instruments- Data processing, coding, tabulation and analysis.	2
6.	Formulation of secondary tables based on objectives of research.	2
7.	Writing report, Writing of thesis and research articles	2
8.	Presentation of reports.	2

Suggested Radings

Chandrakandan K, Venkatapirabu J, Sekar V & Anand Kumar V. 2000. *Tests and Measurements in Social Research*.APH Publ.
Kerlinger FN. 1973. *Foundations of Behavioural Research*. Holt Rhinehart.
Kothari CR.1984. *Research Methodology, Methods and Techniques*. Chaitanya Publ. House.
Krishnaswami OR & Ranganatham M. 2005. *Methodology of Research in Social Sciences*. Himalaya Publ. House.
Mulay S & Sabaratnam VE.1983. *Research Methods in Extension Education.* Manasavan.
Ranjit Kumar. 1999. *Research Methodology - A Step by Step Guide for Beginners*. Sage Publ.
Ray GL & Sagar Mondal. 1999. *Research methods in Social Sciences and Extension Education*. Naya Prokash.
Wilkinson TS & Bhandarkar PC.1993. *Methodology and Techniques of Social Research*. Himalaya Publ. Home.

03MEXT102 Visual Communication 3(2+1)

Objective

This course is intended to give a clear perspective about the importance of visuals and graphics in communication. The course starts with the delineating about the characteristics of visuals and graphics followed by its main functions, theories of visual perception and its classification and selection. Further, the course deals with the designing the message, graphic formats and devices and presentation of data. It makes the students to understand, prepare and present the scientific data effectively by using low cost visuals. The course also exposes the students to various Digitized video material in multimedia and also enable to design visuals for print, TV and know-how about scanning of visuals.

Theory

Role of visuals & graphics in Communication. Characteristics of visuals & graphics. Functions of visuals and graphics. Theories of visual perception. Classification and selection of visuals. Designing message for visuals, Graphic formats and devices. Presentation of Scientific data. Principles and production of low cost visuals. Photographs-reprographic visuals. PC based visuals. Digitized video material in multimedia production. Designing visuals for print and TV and video. Pre-testing and evaluation of visuals. Scanning of visuals.

Practicals

Preparation of low cost projected and Non-Projected visuals. Designing and layout of charts, posters, flash cards etc. Power point presentations. Generating computer aided presentation graphics. Scanning and evaluation of visuals.

Lecture schedule: Theory

S. No.	Topic	No. of lectures
1.	Role of visuals & graphics in Communication.	2
2.	Characteristics of visuals & graphics.	2
3.	Functions of visuals and graphics.	2
4.	Theories of visual perception.	2
5.	Classification and selection of visuals.	2
6.	Designing message for visuals.	2
7.	Graphic formats and devices.	2
8.	Presentation of Scientific data.	2
9.	Principles and production of low cost visuals.	2
10.	Photographs- reprographic visuals.	2
11.	PC based visuals.	2
12.	Degitized video material in multimedia production.	2
13.	Designing visuals for print and TV and video.	2
14.	Pre-testing and evaluation of visuals.	4
15.	Scanning of visuals.	2

Lecture schedule : Practical

S.No.	Topic	No. of Lectures
1.	Preparation of low cost projected and Non-Projected visuals.	4
2.	Designing and layout of charts, posters, flash cards etc.	3
3.	Power point presentations.	3
4.	Generating computer aided presentation graphics.	3
5.	Scanning and evaluation of visuals.	3

Suggested Readings

Bhatia A. 2005. *Visual Communication*. Rajat Publications, New Delhi.

Edgar Dale 1970. *Audio Visual methods in Teaching.* Holt, Rinehart & Winston.

James WB, Richard BL, Fried F Harcleroad. 1952. *A.V. Instructional Material & Methods*. Mc.Graw Hill.

Reddy YN. 1998. *Audio Visual Aids in Teaching, Training and Extension*. Haritha Publ. House, Hyderabad.

03MEXT103 Modern Concepts in Crop Production 3(3+0)

Objective

To teach the basic concepts of soil management and crop production.

Theory:

Agronomic aspects in food security; Crop growth and production in relation to climate change; Agro ecological and agroclimatic zones of India; C oncept of potential yield; Modern concepts in tillage - zero, minimum and conservation tillage; Optimization of plant population and planting geometry in relation to soil fertility, solar radiation and available moisture regimes; Mitscherlich , Baule and Inverse yield : nitrogen laws; Biotic and abiotic stresses; Concept of ideal plant type; Organic farming, Physiology of grain yield in cereals; Crop growth analysis; Crop modelling in agronomic systems; Precision agriculture; Growth regulators and their role in agriculture; Designer crops; Vermi-technology; Agro biodiversity; Seed priming; ; I nd i geno us technolo gical kno wled ge; Herb icid e resistance in weeds; Allelopathy in agriculture ; Plant nutrition and disease tolerance in field crops.

Lecture schedule- Theory

S. No.	Topic	No. of lectures
1	Population and food requirement	1
2	Agronomic techniques for food security, crop nutrition, value addition	2
3	Effect of climate change on crop production	1
4	Direct and interactive effect of different climatic parameters on crop production	2
5	Agroecological and agroclimatic zones of India and their introduction	2
6	Concept of potential yield	1
7	I ntrod uctio n to mo der n co ncep ts o f tillage - zer o tillage minimum tillage, furrow irrigated raised bed system, resource conservation	3
8	Conservation tillage - its advantages, disadvantages , types and Methods	1
9	Relationship between plant population and yield and response curves	1
10	Optimum plant population in relation to soil fertility and solar radiation	1
11	Mitscherlich equation, Baule unit and inverse yield: nitrogen laws	2
12	Abiotic and biotic stresses	2
13	Definition and concept of ideal plant type	1
14	Characteristics of an ideotype plant for dryland agriculture	1
15	Ideotype plant for wheat	1
16	Organic farming – definition, differences between conventional and organic farming and principles and components of organic farming	2
17	Physiology of grain yield in cereals	2
18	Growth curves and analysis of crop growth : LAI, CGR, RGR, NAR, LAD	2
19	Crop model-definition, concept and types (empirical & mechanistic)	1
20	Scientific basis of modelling	1
21.	Model applications	1
22	Precision agriculture-definition, basic concept, scope and approach	1
23.	Technologies for precision agriculture: computers, geographical information system (GIS), global positioning, system (GPS), sensors, etc.	2
24.	Plant growth regulators-definition,types and their role in crop Production	2
25	Designer crops - concept and importance	2
26	Vermi- technology , meaning, methods and scope	2
27	Agro- biodiversity- definition, effects, threats and conservation	2
28	Seed priming- concept, importance and use in crop production	1
29	I nd igeno us techno lo gical kno wled ge and its use in crop production	1
30	Herbicide resistance in weeds – meaning and management of resistant weeds	2
31	Allelopathy in agriculture	1
32	Plant nutrition and disease tolerance in field crops	1

Suggested Readings:

Gardner, F.P.;Pearce, G.R. and Michell, R.I. Physiology of Crop Plants, Scientific Pub., Jodhpur.

03MEXT104 Principles and Practices of Weed Management 3(2+1)

Objective

To familiarize the students about the weeds, herbicides and methods of weed control.

Theory

Weed–biology, ecology and classification; history, development and classification of herbicides, their properties, mode of action and uses, basis of selectivity of herbicides; herbicide mixtures, adjuvants and safeners; weed control principles and management practices in important grain crops, oilseeds, pulses, sugar, fibre crops, tuber crops and forage crops; vegetables and orchards; weed control under specific situations viz. intercropping systems, non-cropped areas and drylands; noxious farm weeds and parasitic weeds and their control; fate of herbicides in soil; herbicide - pesticides and fertilizer interactions; allelopathic effect; integrated weed management; problem of aquatic weeds particularly water hyacinth, hydrilla and typha grass in Rajasthan and their possible control measures; weed control through bio herbicides and myco- herbicides; herbicide resistance in weeds and crops.

Practical:

Identification of common k*harif, rabi* and perennial weeds of crop fields, road sides, waste lands and irrigation channels; familiarization with trade names, common names, uses, cost and source of availability of herbicides; calibration of sprayer and maintenance (before and after use); study of different herbicidal formulations; calculation on herbicidal requirement for field crops and aquatic situation; application of herbicides in field crops; control of some noxious weeds by cultural and chemical means; study on weed control efficiency and calculation on weed infestation and weed index; preparation of weed herbarium, methodology for weed control research and precautions in handling or storage of herbicides.

Lecture schedule – Theory

S. No.	Topic	No. of lectures
1	Weeds- biology, ecology and classification	2
2	Herbicides -	2
	a) History, development and classification of herbicides	2
	b) Properties of herbicides	2
	c) Mode of action and uses of herbicides	2
	d) Basis of selectivity of herbicides	2
3	Herbicide mixtures, adjuvants and safeners	2
4	Weed control principles and management practices in important crops	1
	a) Grain crops	2
	b) Oilseeds and pulses	2
	c) Sugar and fibre crops	1
	d) Tuber and forage crops	2
	e) Vegetable crops	2
	f) Orchards	1
5	Weed control under specific situations – intercropping system, drylands and non cropped area	1
6	Noxious farm weeds, parasitic weeds and their control	1
7	Fate of herbicides in soil	2
8	Herbicide- pesticides and fertiliser interactions	1
9	Allelopathic effects	1
10	Integrated weed management	1
11	Problem of aquatic weeds particularly water hyacinth, hydrilla and typha grass in Rajasthan and their possible control measures	1
12	Weed control through bio-herbicides and myco- herbicides	1
13	Herbicide resistance in weeds and crops	1

Lecture schedule-Practical

S.No.	Topic	No. of lectures
1	Identification of common *Kharif* and *Rabi* weeds	
2.	Identification of perennial weeds of crop fields, road sides, wastelands and irrigation channels	1
3.	Familiarization with trade names, common names, uses, cost and sources of availability of herbicides	1

4.	Calibration of sprayers and maintenance (before and after use)	1
5.	Study of different herbicidal formulations	1
6.	Calculation on herbicidal requirement for field crops under aquatic situations	2
7.	Application of herbicides in field crops	2
8.	Control of some noxious weeds by cultural and chemical means	1
9.	Study on weed control efficiency and calculation on weed infestation and weed index	1
10.	Preparation of weed herbarium	2
11.	Methodology for weed control research	2
12	Precautions in handling or storage of herbicides	1

Suggested Readings :

Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.
Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley Inter-Science.
Gupta OP. 2007. *Weed Management–Principles and Practices.* Agrobios.
Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices*. Agro-Botanical Publ.
Rao VS. 2000. *Principles of Weed Science.* Oxford & IBH.
Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control*. Kalyani.
Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic. Press

BHAGWANT UNIVERSITY

Established by Govt. of Raj. & Recognised by UGC

Sikar Road, Ajmer

RAJASTHAN

Syllabus

M.Sc. (Entomology)

Faculty of Agriculture

Bhagwant University, Ajmer (Raj.)

M.Sc. (Ag.) Course Programs

ENTOMOLOGY

Semester I			
BU COURSE NO.	**ICAR Course No**	**Course Title**	**Credit Hours**
01MENT101	**ENT 511**	Insect Morphology	**3(2+1)**
01MENT102	**ENT 512**	Insect Ecology	**3(2+1)**
01MENT103	**ENT 513**	Principles of Integrated Pest Management	**3(2+1)**
01ENT104	**PPATH513**	Principles of Plant Pathology	**3(3+0)**
	Semester II		
02MENT101	**ENT 521**	Classification of Insects	**3(2+1)**
02MENT102	**ENT 522**	Insect Physiology And Nutrition	**3(2+1)**
02MENT103	**ENT 523**	Toxicology of Insecticides	**3(2+1)**
02MENT104	**ENT 524**	Pests of Field Crops	**2(2+0)**
02MENT105	**STAT 521**	Experimental design	**3(2+1)**
	Semester III		
03MENT101	**ENT 531**	Pests Of Horticultural and Plantation Crops	**3(2+1)**
03MENT102	**ENT 533**	Biological Control of Crop Pests and Weeds	**3(2+1)**
03MENT103	**PPATH532**	Principles of Plant Disease Management	**3(2+1)**
03MENT104	**PPATH533**	Disease Of Field and Medicinal Plants	**3(2+1)**
	Semester IV		
04MENT101	**ENT 541**	M.Sc. Seminar	**1(0+1)**
04MENT102	**ENT 542**	Comprehensive	**2(0+2)**
04MENT103	**ENT 543**	M.Sc. Research	**15**
		Total	**56**

01MENT101 Insect Morphology 3(2+1)

Objective

To acquaint the students with external morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions. To study the anatomy of different systems.

Theory

Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation, Head- Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites, Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications, Abdomen-Segmentation and appendages; Genitalia and their modifications; embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemo- receptors), Structure of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands.

Practical:

Dissection of cockroach/ grass hopper to study comparative anatomical details of different systems. Study of insect segmentation, various tagmata and their appendages; preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs.

Lecture schedule--Theory

S.No.	Topic	No. of lectures
1	Principles, utility and relevance of insect body wall structure and cuticular outgrowths	1
2	Colouration and special integumentary structures in insects	1
3	Insect body tagmata, sclerites and segmentation	1
4	Origin, structure and modification of Head	1
5	Types of mouthparts	3
6	Types of antennae	1
7	Tentorium and neck sclerites	1
8	Areas and sutures of tergum, sternum and pleuron, pterothorax	1
9	Structure and modifications of Wings	1
10	Wing venation	1
11	Wing coupling apparatus and mechanism of flight	2
12	Structure and modifications of Legs	2
13	Segmentation and appendages of abdomen	1
14	Genitalia and their modifications	2
15	Embryonic and post-embryonic development	1
16	Types of metamorphosis	1
17	Insect sense organs (mechano-, photo- and chemo- receptors)	2
18	Structure and function of digestive systems	1
19	Structure and function of circulatory systems	1
20	Structure and function of respiratory systems	1
21	Structure and function of excretory systems	1
22	Structure and function of nervous systems	1
23	Structure and function of sensory organ	1
24	Structure and function of reproductive systems	1
25	Structure and function of musculature	1
26	Structure and function of endocrine and exocrine glands	1

Lecture schedule-- Practical

S.No.	Topic	No. of Lectures
1	Study of insect segmentation	1
2	Study of various tagmata and their appendages	1
3	Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia	6
4	Study of Sense organs	1
5	Dissection of cockroach to study comparative anatomical details of digestive , nervous, excretory systems	7

Suggested Readings

Chapman RF. 1998. *The Insects: Structure and Function*.Cambridge Univ. Press, Cambridge.
David BV &Ananthkrishnan TN. 2004. *General and Applied Entomology*.Tata-McGraw Hill, New Delhi.
Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*.Kalyani Publ., New Delhi.
Evans JW. 2004. *Outlines of Agricultural Entomology*. Asiatic Publ., NewDelhi.
RichardsOW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman & Hall, London.
Saxena RC & Srivastava RC. 2007. *Entomology: At a Glance*. Agrotech Publ. Academy, Jodhpur.
Snodgross RE. 1993. *Principles of Insect Morphology*. Cornell Univ. Press, Ithaca.

01MENT102 Insect Ecology 3(2+1)

Objective

To teach the students the concepts of ecology, basic principles of distribution and abundance of organisms and their causes. Study life tables, organization of communities, diversity indicies. Train students in sampling methodology, calculation of diversity indicies, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

Theory

History and Definition. Basic Concepts. Organisation of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology, Basic concepts of abundance-Model vs Real world. Population growth- basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics-Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects.Classificationand mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation, Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain-web and ecological succession. Interspecific interactions-Basic factors governing the interspecific interactions-Classification of interspecific interactions - The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of niche- ecological homologues, competitive exclusion. Prey-predator interactions- Basic model- Lotka-Volterra Model, Volterra's principle. Functional and numerical response. Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies, Community ecology-Concept of guild, Organisation of communities- Hutchinson Ratio, May's *d/w*, Relation between the two and their association with Dyar's Law and Przibram's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity-stability debate, relevance to pest management. Pest management as applied ecology.

Practical

Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two. Assessing and describing niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagramatic representation of niches of organisms. Calculation of some diversity indices- Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values. Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.

Lecture schedule-- Theory

S.No.	Topic	No. Of Lectures
1	History and definition , Basic Concept	1
2	Organisation of the Biological world	1
3	Plato's Natural balance vs Ecological Dynamics as the modern view	1
4	Abundance and diversity of insects, Estimates and causal factors	1
5	Study of abundance and distribution and relation between the two	1
6	Basic principles of abiotic factors and their generalised action on insects	1
7	Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance and biocoenosis, System approach to ecology	2
8	Basic concepts of abundance- Model vs Real world	1
9	Population growth – basic models –Exponential vs Logistic models	1
10	Discrete vs Continuous growth models	1
11	Concepts of Carrying capacity, Environment Resistance and Optimal yield	1
12	Vital Statistics – Life Tables and their application to insect biology	1
13	Survivorship curves	1
14	Case studies of insect life tables	1

15	Population dynamics – Factors affecting abundance – Environmental factors, dispersal and migration, seasonality in insects	1
16	Classification and mechanisms of achieving different seasonality – Diapause (Quiescence) – aestivation, hibernation	1
17	Biotic factors – Food as a limiting factor for distribution and abundance, Nutritional Ecology	1
18	Food chain – web and ecological succession	1
19	Interspecific interactions – Basic factors governing the interspecific interactions – Classification of interspecific interactions – The argument of cost- benefit ratios	2
20	Competition – Lotka – Volterra model, Concept of niche – ecological homologues, competitive exclusion	1
21	Prey – predator interactions – Basic model – Lotka – Volterra Model, Volterra's Principle	1
22	Functional and numerical response	1
23	Defense mechanisms against predators/parasitoids –Evolution of mimicry, colouration	1
24	Concept of predator satiation ; evolution of life history strategies	1
25	Community ecology – concept of guild	1
26	Organisation of communities – Hutchinson Ratio, May's *d/w* , Relation between the two and their association with Dyar's Law and Przibram's law	1
27	Relative distribution of organisms, Concept of diversity – the Wallacian view	1
28	Assessment of diversity	1
29	Diversity – stability debate, relevance to pest management	1
30	Pest management as applied ecology	1

lecture schedule—Practical

S.No.	Topic	No. Of Lectures
1.	Types of distributions of organisms	1
2.	Methods of sampling insects	1
3.	Estimation of densities of insects and understanding the distribution parameters – Measures of central tendencies	1
4.	Poisson Distribution, Negative Binomial Distribution	1
5.	Determination of optimal sample size	1
6.	Learning to fit basic population growth models and testing the goodness of fit	1
7.	Fitting hollings's Disc equation	1
8.	Assessment of prey – predator densities from natural systems and understanding the correlation between the two	2
9.	Assessing and describing niche of some insects of a single guild	1
10.	Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms	2
11.	Calculation of some diversity indices – Shannon's and Avalanche Index and understanding their associations and parameters that affect their values	1
12.	Problem solving in ecology	2
13.	Field visits to understanding different ecosystem and to study insect occurrence in these systems	1

Suggested Readings

Chapman JL & Reiss MJ. 2006. *Ecology: Principles & Applications*. 2nd Ed. Cambridge Univ. Press, Cambridge.

Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics.*Sinauer Associates, Inc.,

Sunderland, MA.Gotelli NJ. 2001. *A Primer of Ecology.*3rd Ed. Sinauer Associates, Inc.,

Sunderland, MA ,Gupta RK. 2004. *Advances in Insect Biodiversity*. Agrobios, Jodhpur.

Krebs CJ. 1998. *Ecological Methodology*. 2ndEd. Benjamin-Cummings Publ. Co., New York.

Krebs CJ. 2001. *Ecology: The Experimental Analysis of Distribution and Abundance.* 5th Ed. Benjamin Cummings Publ. Co., New York.

Magurran AE. 1988. *Ecological Diversity and its Measurement.* Princeton Univ. Press, Princeton.

Price PW. 1997. *Insect Ecology*. 3rd Ed. John Wiley, New York.

Real LA & Brown JH. (Eds). 1991. *Foundations of Ecology: ClassicPapers with Commentaries*. University of Chicago Press, Chicago.

Southwood TRE & Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Methuen & Co. Ltd., London.

Speight MR, Hunta MD & Watt AD. 2006. *Ecology of Insects: Concepts and Application*. Elsevier Science Publ., The Netherlands.

Wilson EO & William H Bossert WH. 1971. *A Primer of Population Biology*. Harvard University, USA.

Wratten SD & Fry GLA.1980. *Field and Laboratory Exercises in Ecology*.Arnold, London.

01MENT103 Principles of Integrated Pest Management 3(2+1)

Objective

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM**.**
Train students in computation of ETL, implementing IPM programmes.

Theory:

History and origin, definition and evolution of various related terminologies, Concept of IPM; Economic decision levels of insect pest population, Insect dominance, increase in agriculture pest problem, pest outbreak and factors affecting it; Categories of pest, Tools of pest management and their integration- legislative, cultural, physical and mechanical methods, host plant resistance, biological control, semi chemicals, botanicals and chemical control, insecticide resistance management; sampling, survey, surveillance and forecasting. Controversies, criticism and constraints in IPM. Case studies of successful IPM programmes. Pest control appliances and their maintenance.

Practical:

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment- direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system. Use of pest control appliances and their maintenance.

Lecture schedule—Theory

S.No.	Topic	No. Of Lectures
1	IPM- History, origin, definitions and importance.	1
2	IPM -Concept and Economic decision levels ; ETL, EIL & GEP.	2
3	Insect dominance.	1
4	Pest outbreak , causes and factors affecting it.	1
5	Categories of pests.	1
6	Tools of pest management and their integration; cultural control.	1
7	Physical and mechanical control.	2
8	Legislative control.	2
9	Host plant resistance; principles, concept, characterisation and mechanisms and potential in IPM.	2
10	Semiochemicals- pheromones and allelochemicals and their potential in IPM.	1
11	Hormones (IGRs) and their potential in IPM.	1
12	Biological control- definition, techniques, parasitoids and predators; Microbial control- definition, common microbes; advantages and disadvantages of biocontrol.	2
13	Chemical control; classification of insecticides based on mode of entry, action, toxicity and chemical nature; formulations of insecticides.	2
14	Common insecticides and their use- botanicals, chlorinated hydrocarbons, organophosphates, carbamates, synthetic pyrethroids, novel insecticides, chitin synthesis inhibitors, rodenticides, fumigants;	3
15	Insect attractants, repellents and antifeedents,	1
16	Genetic insect control- gamma radiation and chemosterilants.	1
17	Insecticidal poisoning and antidotes; safe use of insecticides.	1
18	Insecticide resistance management.	1
19	Assessment of insect populations-Sampling techniques.	1
20	Survey, surveillance and forecasting of pest populations.	1
21	Controversies, criticism and constraints in IPM.	1
22	Case studies of successful IPM programmes.	1
23	Pest control appliances and their maintenance.	2

Lecture schedule—Practical

S.No.	Topic	No. of lectures
1	Characterization of agro-ecosystems.	2
2	Sampling methods and factors affecting sampling.	2
3	Population estimation methods.	2
4	Crop loss assessment- direct, indirect, potential, avoidable and unavoidable losses.	2
5	Computation of ETL and EIL.	2
6	Crop modelling.	1
7	Designing and implementing IPM system.	1
8	Use of pest control appliances and their maintenance.	4

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Singh R &Chhillar BS. 2006. *Essentials of Agricultural entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.*1st Ed., Springer, New York.

Horowitz AR &Ishaaya I. 2004. *Insect Pest Management: Field and Protected Crops*. Springer, New Delhi.

Ignacimuthu SS &Jayaraj S. 2007. *Biotechnology and Insect Pest anagement*. Elite Publ., New Delhi.

Metcalf RL &Luckman WH. 1982. *Introduction of Insect Pest anagement.* John Wiley & Sons, New York.

Pedigo RL. 2002. *Entomology and Pest Management.* 4th Ed. Prentice Hall, New Delhi.

Norris RF, Caswell-Chen EP &Kogan M. 2002. *Concepts in Integrated Pest Management.* Prentice Hall, New Delhi.

Subramanyam B &Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

01MENT104 Principles of Plant Pathology 3(3+0)

Objective
To introduce the subject of Plant Pathology, its concepts and principles.

Theory
Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens, role of Environment and host nutrition on disease development. Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies-oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens. Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance. Disease management strategies.

Lectures schedule: Theory

S. No.	Topic	No. Of Lectures
1.	Introduction	1
2.	Importantance, definitions and concepts of plant diseases.	3
3.	History and growth of Plant Pathology	3
4.	Biotic and abiotic causes of plant diseases	2
5.	Growth and reproduction of plant pathogens.	3
6.	Survival and dispersal of important plant pathogens.	1
7.	Role of environment and host nutrition on disease development.	2
8.	Host parasite interaction,recognition concept and infection.	3
9.	Symptomatology	2
10.	Disease development-role of enzymes, toxin and growth regulators	4
11.	Defense strategies-oxidative burst, phenolics, phytoalexins, PR proteins and elicitors.	4
12.	Altered plant metabolism as affected by plant pathogens.	2
13.	Genetics of resistance; R genes	2
14.	Mechanism of genetic variation in pathogens.	3
15.	Molecular basis for resistance; marker – assisted selection.	3
16.	Genetic engineering for disease resistance.	3
17.	Disease management strategies.	7

Suggested Readings

Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.
Heitefuss R & Williams PH. 1976. Physiological Plant Pathology. Springer Verlag, Berlin, New York.
Mehrotra RS & Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi.
Singh RS. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi.
Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants Oxford & IBH, New Delhi.
Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH, New Delhi.

02MENT101 Classification of Insects 3(2+1)

OBJECTIVE

To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects.

Theory: Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained, Distinguishing characters, general biology, habits and abitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura.Subclass: Pterygota, Division Palaeoptera– Odonata and Ephemeroptera. Division:Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, rylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera, Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera– Subdivision Endopterygota, Section Neuropteroid- ColeopteroidOrders:Strepsiptera, Megaloptera, Raphidioptera, NeuropterandColeoptera, Section PanorpoidSiphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

Practical

Study of Orders of insects and their identification using taxonomic keys. Keying different Major Orders:Odonata, Orthoptera,Blattodea,Mantodea,Isoptera,Hemiptera,Thysanoptera,Phthiraptera,Neuroptera,Coleoptera,Diptera,Lepidopteraand Hymenoptera. Field visits to collect insects of different orders.

Lecture schedule---Theory

S.No.	Topic	No. of lectures
1.	Brief evolutionary history of Insects- introduction to phylogeny of insects and major classification of superclass Hexapoda.	2
2.	Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them.	1
3.	Order Collembola, Protura, Diplura.	1
4.	Order Archaeognatha, Thysanura.	1
5.	Order Odonata, Ephemeroptera.	1
6.	Order Plecoptera, Blattodea.	1
7.	Order Isoptera.	1
8.	Order Mantodea, Grylloblattodea.	1
9.	Order Dermaptera, Phasmatodea, Mantophasmatodea.	1
10.	Order Orthoptera.	1
11.	Order Embioptera, Zoraptera	1
12.	Order Psocoptera, Phthiraptera	1
13.	Order Thysanoptera	1
14.	Order Hemiptera	3
15.	Order Strepsiptera, Megaloptera	1
16.	Order Raphidioptera, Neuroptera	1
17.	Order Coleoptera	3
18.	Order Mecoptera, Siphonaptera	1
19.	Order Diptera	2
20.	Order Trichoptera	1
21.	Order Lepidoptera	3
22.	Order Hymenoptera	2

Lecture schedule-- Practical

S.No.	Topic	No. Of Lectures
1.	Study of orders of insects and their identification using taxonomic keys.	1
2.	Keying out families of insects of different major Orders: Odonata, Orthoptera	1
3.	Order Blattodea, Mantodea	1
4.	Order Isoptera, Hemiptera	2
5.	Order Thysanoptera, Phthiraptera	1
6.	Order Neuroptera, Coleoptera	2
7.	Order Diptera, Hymenoptera	2
8.	Order Lepidoptera	2
9.	Field visits to collect insects of different orders	4

Suggested Readings

1. Blackwelder RE. 1967. *Taxonomy - A Text and Reference Book.* John Wiley & Sons, New York.
2. Kapoor VC. 1983. *Theory and Practice in Animal Taxonomy.* Oxford & IBH, New Delhi.
3. Mayr E. 1971. *Principles of Systematic Zoology*. Tata McGraw-Hill, New Delhi.
4. Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.*10th Ed. Chapman & Hall, London.
5. Ross HH.1974. *Biological Systematics.* Addison Wesley Publ. Co.
6. Triplehorn CA & Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects.*7thEd. Thomson/Brooks/Cole, USA/Australia

02MENT102 **Insect Physiology & Nutrition** **3(2+1)**

Objective

To impart knowledge to the students on the elimentary physiology, nutritional physiology and their application in entomology.

Theory

Scope and importance of insect physiology and nutrition, physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands, thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapauses, Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular micro- organisms and their role in physiology; artificial diets,

Practical

Preparation of permanent mounts of internal systems; chromatographic analysis of free amino acids of haemolymph; determination of chitin in insect cuticle; examination of insect haemocytes; determination of respiratory quotient; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets.

Lecture schedule—Theory

S.No.	Topic	No. Of Lectures
1	Scope and importance of insect physiology and nutrition	2
2	Physiology of digestive systems	2
3	Physiology of circulatory systems	2
4	Physiology of respiratory systems	2
5	Physiology of excretory systems	2
6	Physiology of nervous systems	2
7	Physiology of sensory organs	2
8	Physiology of reproductive systems	3
9	Physiology of musculature	1
10	Physiology of endocrine and exocrine glands	2
11	physiology of integument	1
12	Moulting process in insect cuticle	1
13	Growth, metamorphosis and diapause	1
14	Role of vitamins, proteins, amino acids in Insect nutrition	2
15	Role of carbohydrates, lipids, minerals and other food constituents in Insect nutrition	2
16	Extra and intra-cellular micro- organisms and their role in physiology	2
17	Artificial diet for rearing of different insects	3

Lecture schedule—Practical

S.No.	Topic	No. Of Lectures
1	Preparation of permanent mounts of internal systems	2
2	Chromatographic analysis of free amino acids of haemolymph	2
3	Determination of chitin in insect cuticle	2
4	Examination of insect haemocytes	2
5	Gel electrophoresis for determination of protein in insect haemolymph	3
6	Preparation of artificial diets of different insects	2
7	Study of food utilization indices	3

Suggested Readings

Chapman RF.1998. *Insects: Structure and Function*. ELBS Ed., London.

Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*.Kalyani Publ., New Delhi.

Kerkut GA & Gilbert LI. 1985. *Comprehensive Insect Physiology, Biochemistry and Pharmacology.* Vols. I-XIII.
Pergamon Press, New York.

Patnaik BD. 2002. *Physiology of Insects*. Dominant, New Delhi.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*.10th Ed. Vol. 1. *Structure, Physiologyand Development.* Chapman & Hall, New York.

Saxena RC & Srivastava RC. 2007. *Entomology at a Glance.* Agrotech Publ. Academy, Jodhpur.

Wigglesworth VB. 1984. *Insect Physiology*. 8th Ed. Chapman & Hall, New York.

02MENT103 Toxicology of Insecticides 3(2+1)

Objective

To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Theory

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India, classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organo- chlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc., principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity ofinsecticides; insecticide compatibility, selectivityandphytotoxicity, Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence, Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

Practical

Insecticide formulations and mixtures; quality control of pesticide formulations; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides; visit to toxicology laboratories. Good laboratory practices.

Lecture schedule-- Theory

S.No.	Topic	No. Of Lectures
1	Definition and scope of insecticide toxicology	1
2	History of chemical control	1
3	Pesticide use and pesticide industry in India	1
4	Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature	1
5	Structure and mode of action of organo-chlorines,	1
6	Structure and mode of action of organophosphates	1
7	Structure and mode of action of carbamates	1
8	Structure and mode of action of pyrethroids, tertiary amines	1
9	Structure and mode of action of neonicotinoids, oxadiazines, phenyl pyrozoles	2
10	Structure and mode of action of growth regulators, microbial	2
11	Structure and mode of action of botanicals, new promising compounds	2
12	Principles of toxicology	1
13	Evaluation of insecticide toxicity	1
14	Joint action of insecticides- synergism, potentiation and antagonism	1
15	Factors affecting of insecticides	1
16	Insecticide compatibility, selectivity and phytotoxicity	1
17	Insecticide metabolism	2
18	Pest resistance to insecticides	1
19	Mechanisms and types of resistance	2
20	Insecticide resistance management and pest resurgence	2
21	Insecticide residues, their significance and environmental implications	2
22	Insecticide Act	1
23	Registration and quality control of insecticides	1
24	Safe use of insecticides	1
25	Diagnosis and treatment of insecticide poisoning	1

Lecture schedule-- Practical

S.No.	Topic	No. Of Lectures
1	Insecticide formulations and mixtures	1
2	Quality control of pesticide formulations	1
3	Laboratory and field evaluation of bio-efficacy of insecticides	2
4	Bioassay techniques	2
5	Probit analysis	1
6	Evaluation of insecticide toxicity and joint action	2
7	Toxicity to beneficial insects	1
8	Pesticide appliance	1
9	Working out doses and concentrations of pesticides	2
10	Visit to toxicology laboratories	1
11	Good laboratory practices	2

Suggested Readings

Chattopadhyay SB. *1985. Principles and Procedures of Plant Protection.*Oxford& IBH, New Delhi.
Gupta HCL.1999. *Insecticides: Toxicology and Uses.*Agrotech Publ., Udaipur.
Ishaaya I &Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.*Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.
Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.*Narosa Publ.
House, New Delhi.
Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

02MENT104 Pests of Field Crops 3(2+1)

Objective

To familiarize the students about nature of damage and seasonal incidence of insect pests that cause loss to major field crops and their effective management by different methods.

Theory

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors, Insect pests of cereals and millets and their management. Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.), Insect pests of pulses, tobacco, oilseeds and their management, Insect pests of fibre crops, forages, sugarcane and their management.

Practical

Field visits, collection and identification of important pests and their natural enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

Lecture schedule-- Theory

S.No.	Topic	No. of Lectures
1	Systematic position, identification, distribution, host range, bionomics, nature and extent of damage, seasonal abundance and management of insect- pests of cereals and millets.	5
2	Insect pests of pulses.	3
3	Insect pests of tobacco.	1
4	Insect pests of oilseeds.	4
5	Insect pests of fibre crops.	4
6	Insect pests of forage crops.	1
7	Insect pests of sugarcane.	3
8	Poly phagous pests- grasshopper, locust, termite, white grubs and red hairy caterpillar.	8
9	Non- insect pests and their management- mites, birds, rodents, snails and slugs.	3

Lecture schedule-- Practical

S.No.	Topic	No. of Lectures
1	Field visits, collection and identification of important pests and their natural enemies	6
2	Detection and estimation of infestation and losses in different crops	4
3	Study of life history of important pests	6

Suggested Readings

Atwal AS, Dhaliwal GS & David BV. 2001. *Elements of Economic Entomology.* Popular Book Depot, Chennai.

Dhaliwal GS, Singh R &Chhillar BS. 2006*. Essentials of Agricultural Entomology.*Kalyani Publ., New Delhi.

Dunston AP. 2007. *The Insects: Beneficial and Harmful Aspects.*
Kalyani Publ., New Delhi
Evans JW. 2005. *Insect Pests and their Control.* Asiatic Publ., New Delhi.
Nair MRGK. 1986. *Insect and Mites of Crops in India.* ICAR, New Delhi. Prakash I&Mathur RP. 1987. *Management of Rodent Pests.* ICAR, New Delhi.
Saxena RC & Srivastava RC. 2007. *Entomology at a Glance.* Agrotech Publ. Academy, Jodhpur.

02MENT105 Experimental Designs 3(2+1)

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. 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

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control, Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design, Factorial experiments, (symmetrical as well as asymmetrical), orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment, 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, resolvable designs and their applications ~ concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

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; Analysis of resolvable designs; Fitting of response surfaces.

Lecture schedule: Theory

S. No.	Topics	No. Of Lectures
1.	Basic concepts of design of experiment	2
2.	Basic principles of designs	3
3.	Uniformity trials	1
4.	Size and shape of plots and blocks	1
5.	Analysis of variance and transformations	2
6.	CRD, RBD and LSD	3
7.	Factorial experiments	4
8.	Confounding in symmetrical factorial experiments	2
9.	Factorial experiments with control treatment	2
10.	Split plot design	2
11.	Strip plot design	2
12.	Analysis of covariance and missing plot techniques	2
13.	crossover designs	1
14.	resolvable designs	1
15.	Response surfaces	2
16.	Experiments with mixtures	2

Lecture schedule: Practical

S. N.	Topics	No. Of Lectures
1.	Formation of plots	1
2.	Formation of blocks	1
3.	Analysis of CRD	1
4.	Analysis of RBD	1
5.	Analysis of LSD	1
6.	Analysis of factorial experiment	1
7.	Analysis of asymmetric factorial experiments	1
8.	Analysis of confounded factorial experiments	1
9.	Analysis with missing data in RBD	1
10.	Analysis with missing data in LSD	1
11.	Transformation of data	1
12.	Analysis of SPD	1
13.	Analysis of strip plot design	1
14.	Analysis of resolvable designs	1
15.	Fitting of response surfaces	2

References:

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

03MENT101 Pests of Horticultural and Plantation Crops 3(2+1)

Objective

To impart knowledge on major pests of horticultural and plantation crops regarding the extent and nature of loss, seasonal history, their integrated management.

Theory

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops, Fruit Crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, *ber*, fig, citrus, *aonla*, pineapple, apple, peach and other temperate fruits, Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, french beans, chow-chow, brinjal, okra, all gourds, gherkin, drumstick, leafy vegetables etc., Plantation crop- coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc.; Spices and Condiments- pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, beetlevine etc., Ornamental, medicinal and aromatic plants and pests in polyhouses/ protected cultivation.

Practical

Collection and identification of important pests and their natural enemies on different crops; study of life history of important insect pests and non- insect pests.

Lecture schedule-- Theory

S.No.	Topic	No. Of Lectures
1.	Pests of mango	2
2.	Pests of guava, banana	2
3.	Pests of jack fruit, papaya, pomegranate	2
4.	Pests of litchi, ber	1
5.	Pests of grapes	2
6.	Pests of fig, aonla	1
7.	Pests of citrus	3
8.	Pests of apple, peach and other temperate fruits	2
9.	Pests of tomato, potato	1
10.	Pests of radish, carrot, beetroot	1
11.	Pests of cole crops	2
12.	Pests of beans	1
13.	Pests of brinjal	1
14.	Pests of okra, drumstick, leafy vegetables	1
15.	Pests of gourds	2
16.	Pests of plantation crops	2
17.	Pests of spices and condiments	1
18.	Pests of beetlevine, ornamental plants, aromatic plants	2
19.	Pests of medicinal plants	1
20.	Pests in polyhouses and protected cultivation	2

Lecture schedule—Practical

S.No.	Topic	No. Of Lectures
1.	Identification of important pests and their natural enemies on different crops; study of life history of important insect pests and non- insect pests: Pests of mango, guava, banana, jack fruit, papaya, pomegranate.	1
2.	Pests of litchi, ber, grapes, fig, aonla	1
3.	Pests of citrus	1
4.	Pests of apple, peach and other temperate fruits	1
5.	Pests of tomato, potato, radish, carrot, beetroot	1
6.	Pests of cole crops, beans	1
7.	Pests of brinjal, okra, drumstick, leafy vegetables, gourds	1
8.	Pests of plantation crops, spices, condiments, ornamental plants, aromatic plants	1
9.	Pests of beetlevine, medicinal plants	1
10.	Pests in polyhouses and protected cultivation	1
11.	Collection a n d study of life history of important insect pests and non- insect pests.	6

Suggested Readings

Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South Asia and their Management.*Kalyani Publ., New Delhi.

Butani DK &Jotwani MG. 1984. *Insects and Vegetables.* Periodical Expert Book Agency, New Delhi.

03MENT102 Biological Control of Crop Pests and Weeds 3(2+1)

Objective

To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like arasitoids, predators and various entomopathogenic microorganisms.

Theory

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation, Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects, Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation, Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

Practical:

Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

Lecture schedule-- Theory

S.No.	Topic	No. of lectures
1.	History, principles and scope of biological control	3
2.	Important groups of parasitoids, predators and pathogens	3
3.	Principles of classical biological control- importation, augmentation and conservation.	2
4.	Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects	3
5.	Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action	6
6.	Biological control of weeds using insects	2
7.	Mass production of quality biocontrol agents- techniques, formulations	3
8.	Economics, field release/ application and evaluation.	2
9.	Successful biological control projects, analysis, trends and future possibilities of biological control.	2
10.	Importation of natural enemies- Quarantine regulations	2
11.	Biotechnology in biological control	2
12.	Semiochemicals in biological control	2

Lecture schedule-- Practical

S.No.	Topic	No.of lectures
1.	Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers.	4
2.	Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds.	2
3.	Field collection of parasitoids and predators	4
4.	Hands-on training in culturing, identification of common insect pathogens	4
5.	Quality control and registration standards for biocontrol agents	2

Suggested Readings

Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.
De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, New York.
Dhaliwal GS & Arora R. 2001. *Integrated Pest Management: Concepts and Approaches.*Kalyani Publ., New Delhi. Gerson H & Smiley RL. 1990. *AcarineBiocontrol Agents–An Illustrated Key and Manual.* Chapman &Hall,New York.
Huffaker CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.
Ignacimuthu SS &Jayaraj S. 2003. *Biological Control of InsectPests*.Phoenix Publ., New Delhi.
Saxena AB. 2003. *Biological Control of Insect Pests.* Anmol Publ., NewDelhi.
Van Driesche& Bellows TS. Jr.1996. *Biological Control*. Chapman & Hall, New York.

03MENT103 Principles of Plant Disease Management 3(2+1)

0bjectives

To acquaint with different strategies for management of plant diseases.

Theory

Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management. Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures. History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.

Practical

In vitro and in vivo evaluation of chemicals and bioagents against plant pathogens; ED and MIC values, study of structural and functional details of sprayers and dusters.

Lectures schedule: Theory

S. No.	Topic	No. of lecture(s)
1	Principles of plant disease management by cultural methods	2
2	Principles of plant disease management by physical methods	2
3	Principles of plant disease management by biological methods	3
4	Principles of plant disease management by chemical methods	3
5	Principles of plant disease management by organic amendments	2
6	Principles of plant disease management by botanicals	2
7	Integrated control measures of plant diseases	2
8	Disease resistance and molecular approach for disease management	2
9	Foliage, seed and soil application of chemicals	2
10	Role of stickers, spreaders and other adjuvants	2
11	Health vis-à-vis environmental hazards	1
12	Residual effects and safety measures	1
13	History of fungicides, bactericides, antibiotics	1
14	Concepts of pathogen, immobilization	1
15	Chemical protection and chemotherapy	1
16	Nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals	6

Lectures schedule: Practical

S. No.	Topic	No. lectures
1	*In vitro* evaluation of chemicals against plant pathogens	4
2	*in vivo* evaluation of chemicals against plant pathogens	4
3	ED values	2
4	MIC values	2
5	Study of structural details of sprayers	2
6	Study of structural details of dusters	2

Suggested Readings

Fry WE. 1982. Principles of Plant Disease Management. Academic Press, New York.
Hewitt HG. 1998. Fungicides in Crop Protection. CABI, Wallington.
Marsh RW. 1972. Systemic Fungicides. Longman, New York.
Nene YL &Thapliyal PN. 1993. Fungicides in Plant Disease Control. Oxford & IBH, N Delhi.
Palti J. 1981. Cultural Practices and Infectious Crop Diseases. Springer- Verlag, New York.
Vyas SC. 1993 Handbook of Systemic Fungicides. Vols. I-III. Tata McGraw Hill, New Delhi.

03MENT104 Diseases of Field and Medicinal Plants 3(2+1)

Objective

To educate about the nature, prevalence, etiology, factors affecting disease development and control measures of field and medicinal crop diseases caused by fungal, bacterial and viral diseases.

Theory

Diseases of Cereal crops- wheat, barley, rice, pearl millet, sorghum and maize. Diseases of Pulse crops- gram, urdbean, mothbean, mungbean, lentil, pigeonpea, soybean. Diseases of Oilseed crops- rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor.Diseases of Cash crops- cotton, sugarcane. Diseases of Fodder legume crops-berseem, oats, guar, lucerne, cowpea. Medicinal crops- plantago, liquorice, mulathi, rosagrass, sacred basil, mentha, ashwagandha, Aloe vera.

Practical

Detailed study of symptoms and host parasite relationship of important diseases of above mentioned crops. Collection and dry preservation of diseased specimens of important crops.

Lectures schedule: Theory

S. No.	Topic	No. of lecturers
1.	General introduction	1
2.	Diseases of wheat.	4
3.	Diseases of barley. sugarcane	1
4.	Diseases of rice	3
5.	Diseases of pearl millet	1
6.	Diseases of sorghum and maize.	2
7.	Diseases of gram	2
8.	Diseases of urdbean, mothbean, mungbean,and lentil.	2
9.	Diseases of pigeonpea and soybean	2
10.	Diseases of rapeseed and mustard, linseed and sesame.	2
11.	Diseases of sunflower, and caster.	1
12.	Diseases of groundnut.	1
13.	Diseases of cotton	1
14.	Diseases of.	2
15.	Diseases of berseem, Lucerne and oats.	1
16.	Diseases of cowpea and guar	1
17.	Diseases of plantago, liquorice and mulathi	2
18.	Diseases of rosagrass, sacred basil and menthe.	2
19.	Diseases of ashwagandha and Aloe vera	1

Lectures schedule: Practical

1.	Study of symptoms and host parasite relationship of diseases of wheat.	2
2.	Study of symptoms and host parasite relationship of diseases of barley.	1
3.	Study of symptoms and host parasite relationship of diseases of pearl millet.	1
4.	Study of symptoms and host parasite relationship of diseases of sorghum & Maize.	1
5.	Study of symptoms and host parasite relationship of diseases of gram.	1
6.	Study of symptoms and host parasite relationship of diseases of mothbean&Mung.	1
7.	Study of symptoms and host parasite relationship of diseases of mustard.	1
8.	Study of symptoms and host parasite relationship of diseases of linseed.	1
9.	Study of symptoms and host parasite relationship of diseases of castor.	1
10.	Study of symptoms and host parasite relationship of diseases of groundnut.	1
11.	Study of symptoms and host parasite relationship of diseases of cotton.	1
12.	Study of symptoms and host parasite relationship of diseases of fodder legumes and medicinal plants.	2
13.	Collection and dry preservation of diseased specimens of important crops.	2

Suggested Readings

Joshi LM, Singh DV & Srivastava KD. 1984. Problems and Progress of Wheat Pathology in South Asia. Malhotra Publ. House, New Delhi.

Rangaswami G. 1999. Diseases of Crop Plants in India. 4th Ed. Prentice Hall of India, N Delhi.

BHAGWANT UNIVERSITY
FACULTY OF AGRICULTURE

ORDINANCES GOVERNING

M.Sc. (Ag.) COURSES

2018-2019

Ordinances Governing M.Sc. (Agriculture)

2 year Course Leading to Masters Degree of Science in agriculture

1. **APPLICAVILITY :**

   This Ordinance shall apply to Masters Degree of Science (Agriculture) Course leading to the degree of Masters of Science.

2. **DEFFINTIONS :**

   (i) **Academic Programme /Programmes** shall mean a programme of course and /or any other Component leading to the degree of Masters of Science.

   (ii) **Academic Year** is a period of 12 months devoted to completion of requirements specified in the Scheme of Teaching and the related examinations.

   (iii) **Board of Studies (BOS)** shall mean the Board of Studies of the Institute concerned.

   (iv) **Course** means a component of the academic programme, carrying a distinctive code no. and specific credits assigned to it.

   (v) **Credit**: one credit is defined as one hour lecture/ two hour lab/3 hour field work per week

   (vi) **University** shall mean Bhagwant University.

   (vii) **Institute** shall mean Institute of Agricultural Sciences and Research.

   (viii) **Examiner** shall mean an examiner who is not in the employment of the University.

   (ix) **Semester System** – A programme wherein each academic year is apportioned into two parts known as semesters.

   (x) **Student** shall mean a person admitted and registered for degree programme in the Institute Agricultural Sciences and Research.

3. ADMISSION

Admission to 2 year Course Leading to Masters Degree programmes will be made as per the rules prescribed by the Academic Council of the University.

3.1 ELIGIBILITY FOR ADMISSION

(a) No candidate shall be eligible for admission unless he/she has passed Bachelors degree in Science Agriculture.

(b) Has cleared the eligibility test such as University Entrance Exam/Any other National or State examination which is considered to be equivalent.

4. DURATION OF COURSE

(a) Total duration of the Course Leading to Masters Degree programmer shall be 2 years, each year comprising of two semesters.

(b) The Maximum permissible period for completing programmes for which the prescribed programmes shall be 06 semesters. Under very special circumstances, the total period may further be extended upto 08 semesters with the approval of the Vice-Chancellor. This excludes the period of expulsion or suspension by the University/medical leave.

5. CURRICULAM AND MINIMUM CREDIT REQUIREMENT.

2 Semesters per year	Total 8 semester
Time	110 working days consisting of 95 instructional days and 15 examination days.
Class hours per week	24 class hours

6. ATTENDANCE

All Students are normally expected to have and attendances of 75% in each subject. The Vice- Chancellor may give relaxation upto 15% on account of illness and other pre-approved occasion. However, under no circumstances. A student with an attendance of less than 60% in a subject, shall be allowed to appear in the semester-End examination of that subject

In case any student appears in the examination by default, who infect has been detained by the institute; his or her result shall be treated as null and void.

7. CANCELLATION OF ADMISSION

The admission of a Student at any stage of study shall be cancelled if:

a) He/She is not found qualified as per UGC/State Government/university norms and guidelines or the eligibility criteria prescribed.

   or

b) He/She is involved in ragging.

   or

c) He/She is found unable to complete the course within the stipulated time as prescribed.

d) He/She is found involved in creating indiscipline in the Intuition/College or in the University.

8. BOARD OF STUDIES

The constitution of the Board of Studies shall be:

(a) The Director of the Institute (Chairperson)

(b) Two Professors

(c) Two Associate Professors

(d) Two Assistant Professors

(e) Two Expert Members

9. ACADEMIC PROGRAMME COMMITTEE

(a) There shall be an Academic Programme Committee in the Department / Institute of the University.

(b) All the teachers of an Institute of Study shall constitute the Academic Programme Committee of which the Director of the Institute shall act as its Chairperson. This Committee shall coordinate the implementation of the courses for optimum utilization of resources and shall also take care of the coordination of the M.Sc. Agriculture programmes with the other programmes run by the different Institutes of the University.

(c) The Academic programmes Committee shall meet as and when required. But at least once every semester. The Chairperson of the Committee will convene the meetings.

10. Assessment of M. Sc. (Agri.) Courses

All courses undertaken by students are evaluated during the semester using internal system of continuous assessment. The students are evaluated on class/tutorial participation, lab work, midterm tests and end semester examinations, which contribute to the final grade awarded for the subject. Students will be notified at the commencement of each courses about the evaluation methods being used for the courses and weight agers given to the different assignments and evaluated activities.

In order to make the evaluation system as similar and transparent with any of the globally reputed educational institutions like Agricultural University and Research Institutes. Here marks obtained in the continuous assessment and end semester examination are added together and a 10- point grading system will be used to award the student with on overall letter grade for the course (Subject).

Distribution of Marks

1. Courses without Practical components

Two Mid – Term Examination	15 + 15 = 30
End – Term Examination	= 70
Total	= 100

2. Course with Practical Components

Two Mid – Term Examination	15 + 15 = 30
Practical Examination	=20
End – Term Examination	= 50
Total	= 100

3. COMPREHENSIVE(542)

4. M. Sc Research (543)

Point No. 3 &4 shall be evaluated as satisfactory / not satisfactory.

SIGNIFICANCE OF GRADES:

The examinations conducted throughout the semester shall be evaluated in numerals assigning 100 marks to each course. The numerical rating shall be converted to ten point system by placing a decimal before the last digit called here-in-after "grade".

GRADE For M.Sc. (Ag.)	EXPRESSION
8.00 and above	Excellent
7.00-7.99	Good
6.00-6.99	Fair
5.00-5.99	Pass
Below 5.00	FAIL

5. EQUIVALENCE OF GRADES IN PERCENT AND AS DIVISION:

Grade x 10.0	= % marks
60% and above	= First Division
Above 50% but below 60%	= Second Division
Below 50%	= Fail

6. MINIMUM GRADE POINT REQUIREMENT FOR PASSING A COURSE/SEMESTER/DEGREE PROGRAMME:

Minimum grade points required are given below;

Passing requirement of	
A course	5.0
A semester	5.5
An academic year	5.5
Degree programme	5.5

11. MINIMUM GRADE POINT REQUIREMENT FOR PASSING A COURSE/SEMESTER/DEGREE PROGRAMME:

Minimum grade points required are given below;

Passing requirement of	
A course	5.0
A semester	5.5
An academic year	5.5
Degree programme	5.5

12. IMPROVEMENT OF GP/OGPA:

A repeat examination shall be held for both the odd and even semesters at the end of the concerned academic year for those students who have failed in any of the courses taught during one or both of the semesters or have failed to appear in any of the examinations, if otherwise, eligible. Students who could not appear in the examinations shall be required to produce valid reasons for the absence.

13. **USE OF UNFAIR MEANS:**

All reported cases for use of unfair means in the examination shall be placed before a Standing 'Unfair Means Hearing Committee' for decision on case basis. The actions under the category of 'Use of Unfair Means' and procedure for dealing with such cases of suspected/alleged/reported use of unfair means shall be specified by the Academic Council.

The following would be considered as unfair means adopted during examinations and other contexts:

i. Communicating with the fellow students for obtaining help.
ii. Copying from the other student's script/report/paper etc.
iii. Possession of any incriminating document whether used or not.
iv. Any approach in direct or indirect form to influence teacher/ invigilator.
v. Unruly behavior, which disrupts academic environment.

17) **STUDENTS GRIEVANCE COMMITTEE:**

In case of any written representation /complaints received from the students within seven days after completion of the examination regarding setting up of the question paper etc. along with specific recommendations of the course Co-ordinators & Director of the Institute, the same shall be considered by the Students Grievance Committee to be constituted by the Vice-Chancellor The Vice Chancellor shall take appropriate decision on the recommendations of the Students Grievance Committee, before the declaration of result (s) of the said examination.

18) **AWARD OF DEGREE**

A student shall be awarded a degree if:

i) He/She has registered himself/herself, undergone the course of study, fulfilled the all requirements and secured the minimum credits prescribed for award of the concerned degree.

ii) Completion of all prescribed courses of total credits.

iii) Passing of all courses individually with minimum Overall Grade Point Average (OGPA) of 5.5.

iv) There are no dues outstanding in his/her name of a Institute of the University/constituent Institution And

v) No disciplinary action is pending against him/her.

16. Notwithstanding anything stated in this Ordinance, for any unforeseen issues arising, and not covered by this Ordinance, or in the event of differences of interpretation , Vice Chancellor may take a decision after obtaining, if necessary, the opinion/ advice of a Committee consisting of any or all the Directors of the Institutes. The Decision of the Vice-Chancellor shall be final.