Faculty of Agriculture

SKDU, Hanumangarh (Raj.)

M.Sc. (Ag.) Course Programs

SOIL SCIENCE

	SEMESTER I		
SKDU 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**
Total			**57**

SEMESTER-I

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

1. Bear RE. 1964. *Chemistry of the Soil.* Oxford and IBH.
2. Bolt GH &Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.
3. 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.

4. Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ. Press. Sposito G. 1984. *The*
5. *Surface Chemistry of Soils*. Oxford Univ. Press.
6. Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press. Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.
7. 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

1. Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
2. Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed.
3. Panima Publ. Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.
4. 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
5. Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.
6. USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.
7. 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.

8. 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

1. Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes& Sons. Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
2. Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.
3. 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.
4. 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.
5. 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:

1. S. Mavi (1994). Introduction to Agrometeorology. Oxford & IBH Publishing Co. New Delhi.
2. P.A. Menon (1989). Our weather. National Book Trust, New Delhi.
3. A.A. Rama Sastu (1984). Weather and Weather forecasting Publication Division, GOI.
4. P.K. Das (1992). The Monsoon. National Book Trust, New Delhi.
5. S. Venkateraman and A. Krishnan. Crops and Weather. Indian Council of Agricultural Research, New Delhi.
6. Critchfield, H.J. 1995. General Climatology, Prentice Hall of India Pvt. Ltd., New Delhi
7. 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.
8. K.L. Joshi, Sinha and D.P. Gupta (1985). Physical Geography, National Council of Educational Research and Training, New Delhi.

9. Vasiraju Radha Krishna Murthy (1995). Practical Manual on Agricultural Meteorology, Kalyani Publishers, Ludhiana.
10. D.S. Lal, 1998. Climatology. Sharda Pustak Bhawan.
11. S.R. Ghadekar, 1991. Meteorology, Agromet Publishers, Nagpur.
12. 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.
13. Vashneya M.C. and Balakrishana Pillai P. 2003. Textbook of Agricultural Meteorology, ICAR.

SEMESTER-II

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 lectures
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

1. Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
2. 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.
3. Mengel K &Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.
4. Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison. Pierzinsky GM, Sims TJ & Vance JF. 2002. *Soils and Environmental Quality.* 2nd Ed. CRC Press.
5. Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.
6. Tisdale SL, Nelson SL, Beaton JD &Havlin JL. 1999. *Soil Fertility and Fertilizers.* 5th Ed. Prentice Hall of India. Troeh FR & Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.

02MSOI102 Soil biology and Biochemistry 3(2+1)

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 lectures
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

1. Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
2. Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
3. McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
4. Metting FB. 1993. *Soil Microbial Ecology – Applications in Agricultural and Environmental Management*. MarceDekker.
5. Paul EA & Ladd JN. 1981. *Soil Biochemistry*. Marcel Dekker.
6. Reddy MV. (Ed.). *Soil Organisms and Litter in the Tropics*. Oxford & IBH.
7. 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.
8. 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 lectures
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

1. 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.
2. 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	3

	fertilizers	
12.	Supergranules fertilizers	1
13.	fertilizers for specific crops/situations and applications	2

Suggested Readings

1. Brady NC & Weil RR. 2002. *The Nature and Properties of Soils.* Pearson Edu.
2. *Fertilizer (Control) Order, 1985 and the Essential Commodities Act*. FAI,New Delhi. Kanwar JS. (Ed.). 1976. *Soil Fertility: Theory and Practice*. ICAR.
3. Olson RA, Army TS, Hanway JJ & Kilmer VJ. 1971. *Fertilizer Technologyand Use.* 2nd Ed. Soil Sci. Soc. Am. Madison.
4. Prasad R & Power JF. *Soil Fertility Management for SustainableAgriculture*. CRC Press. Tisdale SL, Nelson SL, Beaton JD &Havlin JL. 1999. *Soil Fertility and*
5. *Fertilizers.* McMillan Publ.Vogel AI. 1979. *Textbook of Quantitative Inorganic Analysis*. ELBS.

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 Lecture
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. No.	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.

SEMESTER-III

03MSOI101 **Soil Physics** **3(2+1)**

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

1. Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.
2. Ghildyal BP &Tripathi RP. 2001. *Soil Physics*. New Age International.
3. Hanks JR & Ashcroft GL. 1980. *Applied Soil Physics*. Springer Verlag.
4. Hillel D. 1972. *Optimizing the Soil Physical Environment toward Greater Crop Yields*. Academic Press.

5. Hillel D. 1980. *Applications of Soil Physics*. Academic Press.
6. Hillel D. 1980. *Fundamentals of Soil Physics*. Academic Press.
7. Hillel D. 1998. *Environmental Soil Physi*cs. Academic Press.
7. Hillel D. 2003. *Introduction to Environmental Soil Physics*. Academic Press.
8. Indian Society of Soil Science. 2002. *Fundamentals of Soil Science*. ISSS,New Delhi.
9. Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley-Interscience.
10. Kohnke H. 1968. *Soil Physics*. McGraw Hill.
11. Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
12. Oswal MC. 1994. *Soil Physics*. Oxford & IBH.
13. 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

1. Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.
2. Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.
3. 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.
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7. Singh, G.; Kolar, J.S. and Sekhon, H.S. 2002 Recent Advances in Agronomy (Ed). ISA, Publication, New-Delhi.
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10. Havlin J.L., Beaton J.D., Tisdale S.L. and Nel son W.L. 2006. Soil Fertility and Fertilizers. 7th Ed. Prentice Hall.

03MSOI104 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, 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	2

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

Suggested Readings :

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