M.Sc.(Ag.) SOIL SCIENCE AND AGRICULTURAL CHEMISTRY DEGREE PROGRAMME
DISTRIBUTION OF SUBJECTS – 2012 - 13

Core subjects (20 Credits)

SAC 611	Soil Mineralogy, Genesis, Classification and Survey	(2+1) = 3
SAC 612	Analytical Techniques and Instrumentation methods in soil and plant analysis and Isotopes in Agricultural Research	(1+1) = 2
SAC 621	Soil Physics	(1+1) = 2
SAC 622	Soil Chemistry	(2+1) = 3
SAC 623	Remote Sensing and GIS Techniques for Soil and crop studies	(1+1) = 2
SAC 711	Soil Fertility and Fertilizer Use	(2+1) = 3
SAC 712	Management of problematic soils and water	(2+1) = 3
SAC 721	Fertilizer Technology	(1+1) = 2
	Total	**12+8=20**

Minor subjects (9 Credits)

	IInd Semester	(2+1) = 3
	IInd Semester	(2+1) = 3
	IIIrd Semester	(2+1) = 3
	Total	**6+3= 9**

Supporting Subjects (5 Credits)

STA 613	Statistical Methods and Design of Experiments	(2+1) = 3
COM 614	Computer Programming and its Applications	(1+1) = 2
	Total	**3+2 = 5**

Research	(0+20) = 20
Seminar	(0+1) = 1
Total	**0+21 = 21**
Total Credits = 22 + 33 = 55	

Non-Credit Compulsory Courses: Six courses are of general nature and are compulsory for Master's programme.

CODE COURSE TITLE CREDITS

PGS 611 Research methodology (0+1)
PGS 612 Basic concepts in laboratory techniques (0+1)
PGS 622 Technical writing and communications skills (0+1)
PGS 623 (e-Course) Intellectual property and its management in agriculture (1+0)
PGS 714 Library and information services (0+1)
PGS 725 (e-Course) Disaster management (1+0)

M.Sc.(Ag.) Soil Science and Agricultural Chemistry Degree Programme

Semester-Wise Distribution (Regular)

I SEMESTER		
SAC 611	Soil Mineralogy, Genesis, Classification and Survey	(2+1) = 3
SAC 612	Analytical Techniques and Instrumentation methods in soil and plant analysis and Isotopes in Agricultural Research	(1+1) = 2
STA 613	Statistical Methods and Design of Experiments	(2+1) = 3
COM 614	Computer Programming and its Applications	(1+1) = 2
SAC 011	Research	(0+2) = 2
PGS 611	*Research methodology (0+1)*	
PGS 612	*Basic concepts in laboratory techniques (0+1)*	
	Total	**6 + 6 = 12**
II SEMESTER		
SAC 621	Soil Physics	(1+1) = 2
SAC 622	Soil Chemistry	(2+1) = 3
SAC 623	Remote Sensing and GIS Techniques for Soil and crop studies	(1+1) = 2
	Minor outside the department	**(2+1) = 3**
SAC 022	Research	(0+5) = 5
PGS 622	*Technical writing and communications skills (0+1)*	
PGS 623 (e-Course)	*Intellectual property and its management in agriculture (1+0)*	
	Total	**6 + 9 = 15**
III SEMESTER		
SAC 711	Soil Fertility and Fertilizer use	(2+1) = 3
SAC 712	Management of problematic soils and water	(2+1) = 3
	Minor outside the department	**(2+1) = 3**
	Minor outside the department	**(2+1) = 3**
SAC 031	Seminar	(0+1) = 1
SAC 033	Research	(0+5) = 5
PGS 714	*Library and information services (0+1)*	
	Total	**8 + 10 = 18**
IVSEMESTER		
SAC 721	Fertilizer Technology	(1+1) = 2
SAC 044	Research	(0+6) = 6
SAC 045	Viva-Voce	(0+2) = 2
PGS 725 (e-Course)	*Disaster management (1+0)*	
	Total	**1 + 9 = 10**
	Total Credits = 22 + 33 = 55	

M.Sc.(Ag.) SOIL SCIENCE AND AGRICULTURAL CHEMISTRY DEGREE PROGRAMME

Semester wise distribution (Part – Time)

I SEMESTER		
SAC 611	Soil Mineralogy, Genesis, Classification and Survey	(2+1) = 3
SAC 612	Analytical Techniques and Instrumentation methods in soil and plant analysis and Isotopes in Agricultural Research	(1+1) = 2
STA 613	Statistical Methods and Design of Experiments	(2+1) = 3
PGS 611	*Research methodology (0+1)*	
PGS 612	*Basic concepts in laboratory techniques (0+1)*	
	Total	**5+3 = 8**

II SEMESTER		
SAC 621	Soil Physics	(1+1) = 2
SAC 622	Soil Chemistry	(2+1) = 3
	Minor outside the department	(2+1) = 3
PGS 622	*Technical writing and communications skills (0+1)*	
PGS 623 (e-Course)	*Intellectual property and its management in agriculture (1+0)*	
	Total	**5+3 = 8**

III SEMESTER		
SAC 711	Soil Fertility and Fertilizer use	(2+1) = 3
	Minor outside the department	(2+1) = 3
COM 614	Computer Programming and its Applications	(1+1) = 2
SAC 031	Seminar	(0+1) = 1
SAC 011	Research	(0+2) = 2
*PGS 714 **	*Library and information services (0+1)*	
	Total	**5+6 = 11**

IVSEMESTER		
SAC 623	Remote Sensing and GIS Techniques for Soil and crop studies	(1+1) = 2
SAC 022	Research	(0+5) = 5
PGS 725(e-Course)	*Disaster management (1+0)*	
	Total	**1+5= 7**

V SEMESTER		
SAC 712	Management of problematic soils and water	(2+1) = 3
	Minor outside the department	(2+1) = 3
SAC 033	Research	(0+5) = 5
	Total	**4+7 = 11**

VI SEMESTER		
SAC 721	Fertilizer Technology	(1+1) = 2
SAC 044	Research	(0+6) = 6
SAC 045	Viva-Voce	(0+2) = 2
PGS506 (e-course)	*Disaster Management (1+0)*	
	Total	**1 + 9 = 10**
	Total Credits =	**22 + 33 = 55**

SAC 611 - SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY (2+1)

Objectives

The aim of this course is to acquaint students with basic structure of alumino-silicate minerals and to impart knowledge on soil genesis in terms of factors and processes of soil formation, classification of soils and to enable students to conduct soil survey and interpret soil survey reports in terms of land use planning.

Theory

Unit I – Clay minerals, Genesis and Classification

Fundamentals of crystallography, space lattice, isomorphism and polymorphism. Genesis and classification of clay minerals; identification techniques; clay minerals in Indian soils.

Unit II – Soil formation – Weathering, Factors and Processes

Soil formation – concepts and views – stages. Weathering of rocks, mineral transformations; weathering sequences of minerals with special reference to Indian soils. Soil profile; factors and processes of soil formation – Soil forming processes responsible for the development of different soil orders (USDA system).

Unit III – Soil Classification

Soil classification – objectives ; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil maps – usefulness. Soil orders (USDA system). Soils of India and Tamil Nadu.

Unit IV – Soil survey and Interpretation

Soil survey concepts, objectives and 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.

UNIT V – Land evaluation

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 and characterization of different rocks and minerals. Morphological properties of soil profiles in different landforms- laboratory analysis of soils for classification. Grouping soils using available data base in terms of soil quality. Survey and study of soil profiles in selected areas – Cartographic techniques for preparation of base maps and thematic maps, Exercises on soil survey interpretations. Exercises on land

capability classification, storie index rating, productivity rating, land irrigability classification and crop suitability classification.

Lecture schedule

Theory

1. Fundamentals of crystallography, space lattice,
2. Isomorphism and polymorphism
3. Classification, Chemical composition and properties of clay minerals
4. Genesis of crystalline clay minerals
5. Genesis of non crystalline and crystalline minerals
6. Identification techniques of crystalline and non crystalline clay minerals
7. Amorphous soil constituents and their identification
8. Clay minerals in Indian soils.
9. Weathering of rocks and minerals – types of weathering – physical, chemical and biological
10. Weathering sequence and indices with special reference to Indian soils.
11. Factors of soil formation – active and passive
12. Fundamental soil forming processes
13. Specific soil forming processes
14. Soil forming processes responsible for development of different soil orders – A
15. Soil forming processes responsible for development of different soil orders – B
16. **Mid - Semester Examination**
17. Soil classification – concepts and principles
18. Types of soil classification – early and recent
19. Soil taxonomy – salient features and recent trends and Hierarchy of soil taxonomy
20. Differentiating characteristics of taxa and criticism and appreciation of Soil Taxonomy
21. Description of soil orders – Entisol, Inceptisol
22. Description of soil orders – Alfisol, Aridisol, Vertisol
23. Description of soil orders – Mollisol, Histosol, Spodosol
24. Description of soil orders – Oxisol, Ultisol, Andosol and Gelisol
25. Soils of India
26. Soils of Tamil Nadu
27. Methods of soil survey
28. Types of soil survey, soil mapping unit
29. Cartography
30. Soil survey report Preparation and Soil survey interpretation
31. Land evaluation, land capability classification and land irrigability Classification
32. Storie index, soil productivity rating

33. Fertility capability classification
34. Approaches for managing soils and landscapes in the framework of agro-ecosystem.

Practical

1. Identification and characterization of rocks and minerals
2. Petrological analysis of rocks and minerals
3. Soil survey work in the field.
4. Study of Morphological properties soil profile – I
5. Study of Morphological properties soil profile – II
6. Orientation on keys to Soil Taxonomy
7. Particle size analysis
8. Preparation of HCl extract
9. Estimation of acid insolubles and phosphorus
10. Estimation of iron and aluminium
11. Estimation of calcium and magnesium
12. Estimation of sodium and potassium
13. Estimation of total micronutrients
14. Grouping soils using available data for taxonomic classification.
15. Cartographic techniques for preparation of base maps and thematic maps, Processing of field sheets, compilation and obstruction of maps in different scales
16. Land use planning exercises using conventional and RS tools
17. Practical orientation.

References

1. Buol, S.W., Hole, F.D. and Mc Cracken, R.J. 1995. Soil Genesis and Classification. Affiliated East West Press Pvt. Ltd. New Delhi
2. Chandra Prakash Singh. 2004. Applied Geomorphology: A study. B.R. World of Books, New Delhi.
3. Dipak Sarkar. 2003. Fundamentals and Applications of Pedology. Kalyani Publishers, New Delhi.
4. Fundamentals of Soil Science . 2002. ISSS Publication, IARI, New Delhi.
5. Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi
6. Soil Survey Manual. 2004. Scientific Publishers, Jodhpur.
7. USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.

SAC 622: ANALYTICAL TECHNIQUES, INSTRUMENTAL METHODS IN SOIL AND PLANT ANLYSIS AND ISOTOPES IN AGRICULTURAL RESEARCH (1+1)

Objectives-

This course will give thorough exposure to the students about analytical techniques involved in preparation of solutions and the use of various instruments involved in the Physico – chemical analysis of soils and water , analysis of ultimate and proximate constituents of plants , besides imparting knowledge on the application of radioisotopes techniques in soil and plant science research

Unit –I **Analytical chemistry**

Analytical chemistry- Qualitative and quantitative – Basic principles – Volumetric analysis- preparation of standard solutions- types of titration- types of indicators – Gravimetric analysis- principles

Unit-II- **Instrumentation techniques**

Instrumentation techniques- Electrochemical method- Potentiometry- pH measurement – Potentiometric Titration. Conductometry – Conductivity measurement – Conductometric Titration- Principles and theory

Chromatography- Classification- Paper chromatography, Thin layer chromatography, Gas liquid chromatography and High pressure liquid chromatography- Theory and principles

Unit-III- **Optical methods**

Optical methods- Nature of electromagnetic radiations- interaction of EMR with matter - Colorimetry- spectrometry- flame photometry – Turbidimetry – principles and theory

Unit IV- **Atomic absorption spectroscopy, ICPA and NMR**

Atomic absorption spectroscopy – mass spectroscopy- inductively couples plasma emission spectroscopy (ICPA-ES) - Nuclear magnetic resonance spectroscopy (NMR) - theory and principles

Unit V- **Isotopes in agriculture**

Isotopes- stable and radioisotopes- principles of radioactivity- Nuclear fission and fusion- detection and measurement of radioactivity- isotope dilution technique in soil and plant research – Application of isotopes – organic matter, nutrient transformation- fertilizer use efficiency- Radiation hazards- handling of wastes disposal- regulatory aspects- safety norms and regulation

Theory schedule

1. Basic principles of analytical chemistry and volumetric analysis

2. Preparation of standard solution and gravimetric analysis
3. Potentiometry – pH measurement and Potentiometric titration
4. Conductometry- Conductivity measurement, Conductometric titration
5. Chromatography- classification – PC,TLC, GC and HPLC
6. Colorimetry and Spectrophotometry
7. Flame photometry and Turbidimetry
8. Atomic absorption spectroscopy
9. **Mid semester examination**
10. ICPA and NMR
11. Property and decay principles and interaction of radio nucleus with matter
12. Isotope – stable and radioisotopes- properties of radioisotope, Nuclear fission and fusion
13. Detection and measurement of radioactivity
14. Isotope dilution techniques in soil and plant research
15. Application of isotopes – organic matter and nutrient transformation
16. Application of isotopes- fertilizer use efficiency and BNF
17. Radiation hazard- handling and means of wastes disposal and regulation aspects- safety measures and regulation

Practical schedule

1. Preparation and standardization of solutions
2. Understanding types of titration and indicators – acid- base, redox and complexometric
3. Conductometric titration
4. Potentiometric titration
5. Spectrophotometry/ Colorimetry for P estimation
6. Flame photometry for K and Na estimation
7. Atomic absorption Spectrophotometry for micronutrients estimation
8. Chromatographic techniques- paper chromatography, TLC and GLC
9. IPCA for trace elements
10. Turbidimetry/Nephelometry for S estimation
11. Studies on atomic structure, to understand about the concept of activity, rate constant and half life in radioactive elements and to study about different types of radioactive decay reactions
12. Classification of Radioisotope Laboratories and Features of A Radioisotope Laboratory and Storage and handling of radioactive materials and radiation hazards and toxicity
13. Preparation of labelled fertilizer for experiments , Principles and use of proportional counters and Principles and use of GM counters
14. Principles and use of Solid and liquid scintillation counters and neutron moisture meter and autoradiograph
15. Preparation of soil and plant samples for radioactive measurement
16. Setting up of experiment for fertilizer use efficiency and BNF and their calculation
17. Practical orientation

References

1. Hardarson. G. 1990. Use of nuclear techniques in studies of soil- plant relationship. IAEA, Vienna
2. Sharma B.K. 2004. Instrumental methods of chemical analysis (23rd Edition). Goel publication house, Meerut
3. Singh, D., Chhonkar, P.K. and Pandey, R.N. 1999. Soil Plant Water analysis – A methods manual, IARI, New Delhi
4. Sood, D.D., N. Ramamoorthy and A.V.R. Reddy.1995. Principles of Radiochemistry. Indian Association of Chemists and Allied Scientists , BARC, Bombay
5. Srivastava A.K and P.C. Jain. 1986 Chemical analysis an instrumental approach. S Chand and Co. New Delhi
6. Subbiah , B.V., S.K. Das and M.S. Sachdev 1994. Isotopes in soil-Plant nutrition, ICAR, New Delhi
7. Tan, K.H 2003. Soil sampling, preparation and analysis. CRC press/ Taylor and Francis
8. Tandon, H.L.S. 1993. Methods of analysis of soils, fertilizers and waters, FDCO, New Delhi

SAC 621 - SOIL PHYSICS (1+1)

Objectives

The aim of this subject is to impart knowledge to the students on the various concepts of soil physics. It also aims to discuss the various phases of soil physics and their practical application to overcome the physical constraints of the soil.

Theory

Unit I – Mechanical Composition of Soils

Soil physical properties – Importance – composition of soil – minerals and organic constituents – determinations – mass volume relationship. Soil texture – textural classes – classification of different systems – influence on soil properties.

Unit II – Soil Structure and Consistency

Soil structure – soil aggregation – genesis and classification – factors affecting– influence on soil properties and plant growth. Soil consistency – factors influencing – soil plasticity – Atterberg's constants.

Unit III – Soil Colour and Soil Moisture

Soil colour – significance – soil moisture – forms – methods of estimation – energy concepts – potentials – constants – characteristic curves – hysteresis – soil water movement – Hydralic conductivity – measurement of HC in saturated and unsaturated soils.

Unit IV – Soil Air and Soil Temperature

Soil air – composition – significance – renewal – factors influencing – diffusion – mass flow - indices – ODR – effect on plant growth – Soil air management. Soil temperature – importance – factors influencing thermal properties of the soil – effect on plant growth – Soil temperature management.

Unit V – Importance of soil physical conditions for sustained production

Soil physical fertility and productivity – role of soil organic matter and micro organisms in modifying soil physical conditions and improving plant growth. Physical constraints in soil - occurrence – characteristics and impact on plant growth – management of soil physical conditions for sustained production.

Practical

Soil sampling techniques – textural analysis – determination of physical properties – structure – colour – density and porosity – hydraulic conductivity – infiltration rate – aggregate stability – soil moisture characteristic curve – soil temperature measurement .

Lecture schedule

Theory

1. Soil physical properties – importance – soil composition
2. Mineral and organic constituents – determination – mass volume relationship
3. Soil texture – classes – classification – influence on soil properties
4. Soil structure – soil aggregation – genesis – classification
5. Factors affecting soil structure – impact of soil structure on soil properties and plant growth
6. Soil consistency – factors affecting– soil plasticity – Atterberg's constants
7. Soil colour – significance – soil moisture – forms – methods of estimation
8. Energy concepts – potentials – constants - Soil moisture characteristic curves – hysteresis
9. **Mid - Semester Examination**
10. Soil water movement - Hydralic conductivity – measurement of HC in saturated and unsaturated soils
11. Soil air – composition –renewal – factors influencing renewal
12. Diffusion – mass flow – indices – ODR – effect on plant growth - soil air management
13. Soil temperature – importance – conduction, convection and radiation - factors influencing soil temperature - thermal properties of soil – effect on plant growth – Soil temperature management
14. Soil physical fertility and productivity
15. Physical constraints – occurrence- characteristics of physical constraints – impact on plant growth
16. Role of organic matter in modifying the physical conditions of the soil
17. Management of soil physical conditions for sustained production

Practical

1. Collection of soil samples for physical analysis
2. Textural analysis of soil by international pipette method
3. Determination of soil texture (Mechanical analysis) by hydrometer method
4. Determination of bulk density by core sampler method
5. Determination of bulk density by wax coating method
6. Determination of particle density – Pycnometer method
7. Determination of bulk density, particle density and pore space by measuring cylinder and Keen Roezkowski box method
8. Determination of soil colour
9. Determination of water holding capacity
10. Determination of infiltration rate
11. Determination of hydraulic conductivity
12. Determination of soil moisture constants
13. Determination of soil consistency
14. Aggregate analysis – dry sieving and wet sieving method
15. Determination of soil temperature
16. Preparation of soil moisture characteristic curves
17. Practical Orientation.

Reference

1. Baver, L.D., Gardener, W.U. and Gardner, R.H. 1983. Soil Physics. Wiley Eastern Ltd., New Delhi.
2. Biswas, T.D. and Mukherjee, S.K. 1994. Text Book of Soil Science. Tata Mc. Graw Hill Publishing Company Ltd., New Delhi.
3. Ghildyal, B.P. and Tripathi, R.P. 1987. Soil Physics. Wiley Eastern Limited, New Delhi.
4. Helmat Kohnke.1968 Soil Physics. Tata Mc. Graw Hill Publishing Company Ltd., New Delhi.
5. Majumdar, S.P. and Singh, R.A. 2002. Analysis of soil physical properties. Agrobios (India), Jodhpur.
6. Oswal, M.C. 1994. Soil Physics. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
7. Scott, M. Don. 2000. Soil Physics ; Agricultural and Environmental Applications. Iowa State University Press, USA.
8. Singh, R.A. 1997. Soil physical analysis. Kalyani Publishers, Ludhiana

SAC 622. SOIL CHEMISTRY (2+1)

Objective

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

Theory

UNIT I: Soil chemical composition and soil colloids

Chemical (elemental) composition of the earth's crust- mineral and organic constituents of soil – clay minerals – structure – properties – nomenclature and classification. Effect of clay minerals on fertility of soil and plant growth

UNIT II: Electrochemistry and chemical kinetics.

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.

UNIT III: Ion exchange processes

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Krishnamoorthy & Overstreet equation Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity. measurement, thermodynamics, statistical mechanics; 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. Buffering capacity of soils

Unit IV: Soil organic matter

Soil organic matter – sources, composition, carbon cycle - bio-degradation of organic matter. Fractionation of soil organic matter. Humus formation – role of humus, clay humus complex and chelation – significance of chelation in soil. Metal – organic complex reactions. Significance of organic matter in soil fertility. Carbon sequestration in different ecosystem and its significance on soils and environment.

UNIT V: Nutrient fixation and chemistry of submerged soils

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 submerged soils – Chemical changes – development of aerobic and anaerobic soil layers – changes in redox potential, pH – sequential reduction of oxidation–reduction system – change in specific conductance – ion exchange – sorption and desorption – reduction of Fe (III) to Fe (II) – reduction of Mn (IV) to Mn (II) – effect of chemical and electrochemical changes on rice growth – mineral equilibiria in submerged soils.

Practicals

Determination of CEC and AEC of soil using different extractants; Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter; Point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method; Organic matter content in soil-wet digestion method; Fractionation of humic substances., Potentiometric and conductometric titration of soil humic and fulvic acids, (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies on Δ (E4/E6) values at two pH values; Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm; Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved; Determination of P and K buffering capacity of soil; Determination of P and K fixing capacity of soils; Measurement of redox potential of soil;

Lecture schedule

Theory

1. Chemical (elemental) composition of the earth's crust and soil
2. Mineral constituents of soil.
3. Clay minerals – classification, structure and properties I
4. Clay minerals – classification, structure and properties II
5. Genesis of clay minerals and importance of clay minerals in relation to fertility of soil and plant growth
6. Elements of equilibrium thermodynamics
7. Soil colloids: origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge.
8. Surface charge characteristics of soils
9. Diffuse double layer theories of soil colloids, zeta potential,
10. Coagulation/flocculation and peptization of soil colloids
11. Electrometric properties of soil colloids
12. Sorption properties of soil colloids

13. Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny'sconcept).
14. Adsorption isotherms, donnan-membrane equilibrium concept
15. Membrane electrodes and ionic activity measurement
16. Thermodynamics- statistical mechanics
17. Anion and ligand exchange – innersphere and outer-sphere surface complex formation
18. Mid semester examination
19. Fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions.
20. Shift of PZC on ligand exchange, AEC and CEC
21. Experimental methods to study ion exchange phenomena and practical implications in plant nutrition.
22. Soil reaction and buffering capacity of soils
23. Soil organic matter – sources, chemical composition of organic wastes
24. Carbon cycle and Fractionations of soil organic matter
25. Biodegradation of organic matter under anaerobic and aerobic conditions
26. Humus formation in soils – nature and characteristics of humus – role and functions of humus in soil
27. Clay humus complex and chelation – significance of chelation in soil, metal – organic complex reactions in relation to soil fertility
28. Carbon sequestration in different ecosystem and its significance on soils and environment.
29. Ammonium and Potassium fixation in soil and N and K management
30. Phosphorus fixation in soil and P management
31. Redox chemistry of soil involving organic constituents
32. Redox chemistry of soil involving inorganic constituents
33. Chemistry of submerged soil - Chemical and electrochemical changes in submerged soils – development of aerobic and anaerobic soil layers. Changes in redox potential.
34. Changes in pH – sequential reduction of nutrients. Changes in specific conductance – ion exchange – sorption and desorption Cation exchange reactions involving iron.Cation exchange reactions involving manganese.Mineral equilibria in submerged soils

Practicals

1. Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter
2. Determination of CEC of soil using different extract ants
3. Determination of AEC of soils
4. Determination of point of zero-charge and associated surface charge characteristics by the serial Potentiometric titration method
5. Estimation of organic matter content in soil-wet digestion method
6. Fractionation of humic substances
7. Potentiometric and conductometric titration of soil humic and fulvic acids

8. (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies an Δ (E4/E6) values at two pH values
9. Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm
10. Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved
11. Determination of Ammonium fixing capacity of soil
12. Determination of P buffering capacity of soil
13. Determination of P fixing capacity of soils
14. Determination of K buffering capacity of soil
15. Determination of K fixing capacity of soils
16. Measurement of redox potential of soil
17. Practical orientation

References

1. Baruah, T.C. and Barthakur, H.P. 1997. *A text book of soil analysis*. Vikas Publishing House Pvt. Ltd.,
2. Bear, F.E. (Ed.) 1986. *Chemistry of soil* (3rd Ed.). Oxford and IBH. Publishing Co. Pvt. Ltd., Calcutta.
3. Jackson, M.L. 1973. *Soil chemical analysis*. Prentice Hall of India, New Delhi.
4. MukerjeeJ.N. 1974. *Mineralogy of Soil clays and clay minerals*. ISSN. Bull.No.9
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8. Tan, K.H. 1982. *Principles of soil chemistry*. Marcel Dekker Inc., New York.

SAC 623 REMOTE SENSING AND GIS FOR SOIL AND CROP STUDIES (1 +1)

OBJECTIVES:

The courses imparts knowledge about the basic concepts of remote sensing, aerial photographs and imageries, and their interpretation; application of remote sensing with special reference to soil, plants and yield forecasting. To impart knowledge about concepts of Geographic Information System (GIS), Global Positioning System (GPS) and applications of GIS in agriculture.

Theory

UNIT – I Remote Sensing Concepts

Remote Sensing - principles and basic concepts – Characteristics of electromagnetic radiation – interaction of electromagnetic radiation- passive and active remote sensing - sensors and platforms – microwave radio meters and scanners - Aerial photography - Satellite data acquisition – elements of image interpretation – satellite data products – digital image processing – interpretation and classification.

UNIT – II– Geographic Information System

Geographic information system– principles and concepts - Components of GIS — application for spatial and non-spatial soil and land attributes – applications of GIS in agriculture - Remote Sensing and GIS softwares. Global Positioning System – principles and concepts – functions – applications in agriculture.

UNIT – III– Remote Sensing and GIS application in soils

Use of satellite data in soil resource inventory - Soil information system (SIS) – Concepts – Application of SIS – Land Evaluation – Land capability Classification – storie index rating, productivity rating, land irrigability classification, Crop suitability, Fertility capability classification – Soil quality – Pedo-transfer functions.

UNIT – IV– Remote Sensing and GIS application in crops

Remote sensing in crop inventory- cropping system analysis -production estimation - Crop monitoring and condition assessment- Agricultural drought assessment- hyperspectral sensors and its applications in agriculture-land use and land cover mapping - precision farming - Site specific nutrient management.

UNIT – V – Land use planning

Land use planning –Modern techniques for Land use planning – Watershed level planning. Land degradation – Physical – Chemical – Biological – extent – cause – management. Wastelands – types of wastelands- wasteland mapping – management of wastelands.

PRACTICAL

Morphological evaluation of soil – Soil map – Soil Survey – Land evaluation – GIS – Thematic map preparation – Field visit – Soil fertility evaluation.

LECTURE SCHEDULE

1. Introduction to remote sensing – principles and concepts
2. Electromagnetic energy –propagation theories, sources and spectrum
3. Interaction of electromagnetic radiation
4. Remote sensing platforms and sensors - microwave radio meters and scanners
5. Satellite data acquisition and Satellite data products
6. Elements of image interpretation – digital image processing
7. GIS – principles and components
8. GPS- principles, concepts and functions
9. MID SEMESTER EXAMINATION
10. Remote sensing in soil survey
11. Soil information system – concepts and application
12. Land evaluation – land capability, land suitability

13. Soil quality-Pedo transfer functions
14. Remote sensing in crop inventory
15. Hyperspectral sensors and its applications in agriculture
16. Precision farming, Site specific nutrient management.
17. Land use planning, Land degradation, Waste lands – mapping and management

PRACTICAL SCHEDULE

1. Morphological evaluation of soils
2. Soil map and soil survey report preparation
3. Land capability classification
4. Land irrigability classification
5. Storie index rating
6. Fertility capability classification
7. Crop suitability classification
8. Satellite data products
9. Aerial photograph interpretation for soils
10. Visual interpretation of imageries for soils and land use
11. Digital image processing
12. Preparation of land use map
13. Thematic map preparation using GIS
14. Ground truth radiometer
15. GPS- Collection of GPS points
16. Field visit to waste lands and land-use appraisal
17. Record Certification

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1. Anji Reddy, M. 2001. An introduction to Remote sensing and Geographical Information Systems, B.S.Publications, Hyderabad.
2. Burrough, P.A.1989. Principles of Geographical information Systems for land Resources Assessment. Oxford Univeristy, Clarendon Press, London
3. Dipak Sarkar, 2003. Fundamentals and Applications of Pedology. Kalyani Publishers, Ludhiana
4. Lillesand, M and Kiefer, R.W. 1994. Remote Sensing and Image interpretation (3rd Ed.) John Wiley and Sons, NewYork.
5. Sahu, D.D.2003. Agrometerology and Remote sensing, Principles and Practices, Agrobios (India), Jodhpur.

SAC.711 Soil Fertility and Fertilizer Use (2+1)

Objectives

The main objective is to impart knowledge about soil fertility and the role of fertilizers and manures in supplying nutrients to plants for sustainable agriculture. By the end of the course, the students will be able to understand the mechanism of nutrient absorption by plants and dynamics of soil nutrients.

Unit I – Soil fertility and Plant nutrition

Soil fertility –problems and prospects – Elements in plant nutrition-sources – functions and deficiency symptoms- Nutrient mobility in soils and plants- Mechanism of nutrient uptake and transport in plants

Unit II- Transformation of N in soil

Soil nitrogen – sources, forms and transformation, fixation and release in arable and submerged soils; biological nitrogen fixation and factors affecting . Nitrogenous fertilizers and their fate in soils- management of fertilizer nitrogen in lowland and upland conditions for higher use efficiency.

Unit III- Transformation of P and K in soil

Soil phosphorus – forms, transformation, fixation and release in arable and submerged soils; factors affecting - quantity – intensity relationships- phosphorus availability in soils; phosphatic fertilizers – behavior in soils- management of phosphatic fertilizers in lowland and upland conditions for higher use efficiency- Potassium – forms, equilibrium in soils and agricultural significance- potassium fixation- mechanism-factors affecting fixation- quantity – intensity relationships - management of potash fertilizers in lowland and upland conditions for higher use efficiency.

Unit 1V- Behavior of secondary and Micronutrients in soil

Sulphur – source, forms, fertilizers and their behavior in arable and submerged soils; calcium and magnesium – factors affecting their availability in soils; management of sulphur, calcium and magnesium – fertilizer sources - Micronutrients – critical limits in soils and plants- factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability. Fertilizer use efficiency- soil fertility management - Balanced fertilization- INM - site-specific nutrient management--soil quality in relation to sustainable agriculture.

Unit V- Soil fertility evaluation and fertilizer recommendations

Soil fertility evaluation – concepts, approaches – Biological and chemical methods - soil test crop response correlations and response functions- DRIS. Modern approaches in fertilizer recommendation, Soil testing, Long term fertilizer experiment and its significance

Practical

Chemical analysis of soil for available nutrients – Major, secondary and micro nutrients- interpretation-Analysis of plants for essential elements- Major, secondary and micro nutrients

Theory Lecture Schedule

1. Introduction – importance of soil fertility in crop production – Problems and Prospects
2. Nutrient elements – Arnon's criteria of essentiality – classification of essential nutrients –Ionic forms of plant nutrients in soil
3. Functions of nutrients in plants
4. Deficiency and toxicity symptoms – corrective and management measures
5. Nutrient mobility –concepts- soils and plants
6. Mechanism of nutrient uptake and transport in plants
7. Nitrogen cycle – sources, forms – factors influencing content of nitrogen in soil
8. Transformation in soils – mineralization (aminisation and ammonification) – Nitrification – factors affecting nitrification –fate of released ammonium and nitrate nitrogen.
9. Ammonium fixation- factors affecting, Nitrogen loss mechanism in soil– methods to minimize N losses
10. Biological nitrogen fixation– symbiotic and non symbiotic microorganisms
11. Transformation in submerged soils
12. Commercial N fertilizers – classification –Fate of fertilizer nitrogen in soil-nitrogen balance sheet – gains and losses - crop response to fertilizer N
13. Management of fertilizer nitrogen in upland and submerged conditions for increased fertilizer use efficiency
14. Phosphorus cycle – Sources, forms and transformation in arable and submerged soils
15. P fixation – mechanism and release- methods to reduce phosphate fixation
16. Factors affecting phosphorus availability in soils- QI relationship
17. Phosphatic fertilizers- - classification - behavior of fertilizer P in soils-
18. Mid- semester examination
19. Crop response to P fertilizer- P use efficiency
20. P management under upland and lowland conditions

21. Potassium – content in soil – source – forms of soil potassium – Equilibrium in soils and its agricultural significance
22. Potassium fixation-release- factors affecting-Potassium availability- K buffering- QI relationship
23. Potassium fertilizers- behavior in soils -management under upland and lowland conditions
24. Sulphur – sources , forms - transformation in arable and submerged soil-crop response-Commercial sources of sulphur
25. Calcium and Magnesium – sources, forms– Commercial sources
26. Micronutrients – Dynamics and reactions of Fe, Mn, Cu and Zn in soil and crop response
27. Dynamics and reactions of B, Mo, and Cl in soil and crop response
28. Micronutrient fertilizer for crop production- method of application
29. Fertilizer use efficiency- soil fertility management - Balanced fertilization
30. INM - Site-Specific Nutrient Management--soil quality in relation to sustainable agriculture.
31. Soil fertility evaluation concepts– approaches
32. Evaluation techniques- chemical and biological methods- rating-interpretation
33. STCR-Diagnosis Recommendation Integrated System (DRIS) approaches
34. Soil testing, Long term fertilizer experiment -significance Modern approaches in fertilizer recommendation.

Practical Schedule

1. Estimation of inorganic N – 2M KCl extraction
2. Available N estimation – $KMnO_4$ method
3. Available P estimation – Olsen – P and Bray – P
4. Available K estimation – 1N NH_4OAC - K and 0.1N HNO_3 – K
5. Exchangeable Ca and Mg – Versenate titration method
6. Available S- 0.15 % $CaCl_2$ extraction
7. Estimation of DTPA - Fe, Mn, Cu, Zn
8. Estimation of available B in soil
9. Estimation of available Mo in soil
10. Calculation of primary, secondary and micronutrients requirements – annual and perennial crops
11. Analysis of total N in plant
12. Analysis of total P and S in plant
13. Analysis of K, Ca and Mg in plants
14. Analysis of total Fe, Mn, Zn and Cu in plant
15. Analysis of total B in plant
16. Fertilizer prescription based on STCR approach
17. Practical orientation

References

1. John Havlin, James Beaten, Samuel Tisdale and Werner Nelson, 2005. *Soil Fertility and Fertilizers - An Introduction to Nutrient Management.* 7th Edition, Prentice Hall. Upper Saddle River, NJ.
2. Kanwar. J.S. 1976. *Soil fertility – Theory and Practice*. ICAR- New Delhi.
3. Russell. E.J.1973. *Soil conditions and plant growth*, Tenth edition English Language Book Society, London.
4. Mengel.K. 2006. *Principles of Plant Nutrition*, 5th Edn. Atlas Books and Periodicals, New Delhi
5. Stevenson, F.J. and Cole M.A.1999. *Cycles of Soil: Carbon, Nitrogen , Phosphorus, Sulphur, micronutrients.* John Wiley and Sons, Newyork
6. Miller, C.E. 2004. *Soil Fertility*. International Books and Periodical supply services, New Delhi
7. Mortvedt, J.J., Shuman,L.M., Cox,F.R., and Welch.R.M.1991.*Micronutrients in Agriculture*, 2nd Ed. SSSA, Madison
8. ISSS 2009. Fundamentals of Soil Science. 2nd Edn. N.N.Goswami et al., Eds. Published by Indian Society of Soil Science, New Delhi.

SAC- 712 MANAGEMENT OF PROBLEMATIC SOILS AND WATER (2+1)

Objectives

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 for crop production.

Theory

UNIT I: Wastelands

Degraded lands – area and distribution - concepts – causes – their classification. Wastelands- definition, extent. Cultivable wastelands- gullied, ravine, waterlogged and marshy lands. Uncultivable wastelands – barren rocky, stony, steep sloping lands and their management.

UNIT II: Salt affected soils

Area and distribution- Origin and basic concept of salt affected soils Morphological features of saline, sodic and saline-sodic soils. Characterization of salt-affected soils - soluble salts, ESP, pH. Physical, chemical and microbiological properties of salt affected soils. Management of salt-affected soils- salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field.

UNIT III: Physically degraded soils

Physically degraded soils – surface crusting and hardening subsoil hardpan, fluffy soil, slowly and highly permeable soils - Characteristics and management. Management principles for sandy, clayey, red lateritic and dry land soils.

UNIT IV: Acid soils

Acid soils – area, distribution, nature and sources of soil acidity. Effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management. Acid sulphate soil – genesis – characteristics and management

UNIT V: Irrigation water quality

Quality of irrigation water – Sources of poor quality water – quality parameters- indices and classification. Management of brackish water for irrigation; salt balance under irrigation; Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practicals

Characterization of acid, acid sulphate, salt-affected and calcareous soils. Determination of cations (Na+, K+, Ca++ and Mg++) in ground water and soil samples. Determination of anions (Cl-, SO_4^{--}, CO_3^{--} and HCO_3^{-}) in ground waters and soil samples. Lime and gypsum requirements of acid and sodic soils

Lecture schedule

Theory

1. Degraded lands – area distribution - classification
2. Non- forest public degraded lands
3. Degraded forest lands and private degraded lands
4. Wastelands – introduction and extend
5. Cultivable wastelands- gullied/ravine land, waterlogged and marshy lands
6. Management of cultivable wastelands
7. Uncultivable wastelands – rocky, stony and steep sloping
8. Management of uncultivable wastelands
9. Area and distribution of problem soils –saline, sodic and saline sodic soils
10. Origin and basic concept of problematic soils.
11. Morphological features of saline, sodic and saline-sodic soils;
12. Characterization of salt-affected soils - soluble salts, ESP, pH
13. Physical, chemical and microbiological properties.
14. Management of salt-affected soils; salt tolerance of crops - mechanism and ratings
15. Monitoring of soil salinity in the field
16.. Surface crusting and hardening and its management
17. Mid – Semester Examination
18. Hard pan formation and its management

19. Slowly permeable, highly permeable soil and their management
20. Waterlogged soils, poorly drained soils and their management
21. Fluffy paddy soils and its management
22. Management principles for sandy and clayey soils
23. Management principles for red lateritic and dry land soils.
24. Acid soils - nature of soil acidity, sources of soil acidity
25. Effect of acidity on plant growth
26. Lime requirement of acid soils, liming material and effect of over liming
27. Management of acid soils
28. Acid sulphate soil – genesis – characteristics and management
29. Biological sickness of soils and its management.
30. Quality of irrigation water - quality parameters- indices and classification
31. Charecteristics and management of brackish water for irrigation
32. Salt balance under irrigation
33. Agronomic practices in relation to problematic soils
34. Cropping pattern for utilizing poor quality ground waters.

Practical Schedule

1. Morphological evaluation of Problem soils (Soil colour, texture and consistency)
2. Determination of Bulk density
3. Determination of particle density and pore space
4. Analysis of chemical properties – pH and EC
5. Determination of active acidity in soil
6. Determination of reserve acidity ion soil
7. Determination of lime requirement
8. Determination of water soluble cations in soil – Ca and Mg
9. Determination of water soluble cations in soil – Na and K
10. Determination of water soluble anions in soil – CO_3 and HCO_3
11. Determination of water soluble anions in soil – Cl and SO_4 and SAR
12. Leaching requirement of soil
13. Determination of CEC and ESP
14. Determination of cations in irrigation water
15. Determination of anions in irrigation water
16. Irrigation water quality assessment
17. Practical orientation

Reference

1. Abrol.I.P., and V.V. Dhruva Narayana. 1990. Technologies for wastelands development. ICAR Publication, New Delhi.
2. Biswas,T.D. and G.Narayanasamy (Eds.). 1996. Soil management in relation to land degradation and environment. Bulletin No.17, ISSS, New Delhi.

3. Gupta, I.C., D.P. Sharma and S.K. Gupta, 1995. Alkali Wastelands – Environment and Reclamation. Scientific Publishers, Jodhpur.
4. Jurinak, J.J. 1978. *Salt-affected Soils*. Department of Soil Science and Biometeorology. Utah State Univ.
5. Sharma,V.K. 2000. Greening Wastelands, Management and Techniques. Deep and Deep Publication Pvt. Ltd., New Delhi.
6. Somani,L.L.1998. Crop production with saline water. Agro Botanica, Vyas Nagar, Bikaner.
7. USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

SAC 721 – FERTILISER TECHNOLOGY (1+1)

Objectives

This subject aims to provide information to the students about the fertilizer production and consumption scenario in India, besides providing knowledge on the manufacture of major, secondary and micronutrient fertilizers .

Theory

Unit I – Fertiliser Scenario in India and Nitrogenous Fertilisers

Fertiliser production, consumption in different countries, India and Tamil Nadu – future projection concepts and classification of fertilisers. Chemistry and production technology of nitrogenous fertilisers – slow release nitrogenous fertilisers.

Unit II – Phosphatic and Potassic Fertilisers

Chemistry and production technology of phosphatic fertilisers- rock phosphate, phosphoric acid, straight and compound P fertiliser production, modified products of 'P' carriers . Production technology of potassic fertilizers – relative efficacy of K fertilizers.

Unit III – Secondary and Micronutrient Fertilisers

Secondary nutrient fertilizers - sources – production. Micronutrient fertilisers production –Production of multi-micronutrient fertilisers and their use. Micronutrient fortification – Methods of application of fertilizers.

Unit IV – Complex and Mixed Fertilisers

Complex fertilisers and standard fertiliser mixtures – production. Water soluble and customized fertilizers – liquid fertilisers. Compatibility of fertiliser mixtures – fertiliser - pesticide interactions. Soil amendments – quality assessments.

Unit V – Fertiliser Control Order and Fertiliser in Soils and Environment

Quality control of fertilisers – fertiliser control order – physical and chemical standards of straight, complex and mixed fertilisers – long term effect of fertilisers in soils

and environment. Fertiliser mixture recommended for Tamil Nadu as per FCO. Nutrient based subsidy programme of GOI.

Practical

Sampling of straight, mixed and compound fertilisers for analysis – moisture estimation – analysis of N fertilisers for various forms – biuret estimation in urea – analysis of P and K fertilisers by FCO methods and for different forms. Estimation of micronutrients in fertilizers – quality control standards – visit to fertiliser manufacturing, processing industries and fertilizer quality control laboratory.

Lecture schedule

Theory

1. Fertiliser production, consumption in different countries, India and Tamil Nadu. future projection. Concepts and classification of fertilisers.
2. Production technology of nitrogeneous fertilizers
3. Production technology of nitrogeneous fertilisers
4. Slow release N fertilizers and relative efficiency of fertilisers in different soils
5. Chemistry and production technology of phosphatic fertilisers - rockphosphate, straight and compound 'P' fertilisers,
6. Modified production of 'P' carriers
7. Terminology used in P fertiliser industry.
8. Production technology of potassic fertilizers – relative efficacy of K fertilizers.
9. **Mid - Semester Examination**
10. Secondary nutrient fertilisers – Ca, Mg and S – sources, production
11. Production technology of micronutrient fertilisers and micronutrient fortification
12. Production technology of complex and standard fertilisers mixtures and efficiency
13. Water soluble and customized fertilizers and liquid fertilizers. Soil amendments – quality assessment.
14. Compatibility of fertiliser mixtures and fertilizers pesticides interaction
15. Fertiliser control order
16. Physical and chemical standards of straight, complex and mixed fertilisers
17. Effect of long term application of fertilisers in soil and environment and Fertiliser mixture recommended for Tamil Nadu as per FCO.

Practical

1. Fertilizers sampling procedures and techniques
2. Estimation of free acidity and basicity
3. Estimation of NH_4- N in N fertilisers (Ammonium sulphate, Ammonium chloride and DAP)
4. Estimation of NO_3-N in N fertiliser (Potassium nitrate, Sodium nitrate)
5. Estimation of NH_4-N and NO_3-N in N fertiliser (Calcium ammonium nitrate)

6. Estimation of NH_2-N in urea (Digestion)
7. Estimation of NH_2-N in urea (Estimation)
8. Estimation of total 'P' content in RP– digestion
9. Estimation of Total 'P' content in RP- estimation
10. Estimation of water soluble 'P' in SSP & DAP
11. Estimation of water soluble and citrate soluble P in DCP
12. Estimation of K content in muriate of potash and sulphate potash
13. Estimation of S content in ammonium sulphate, SSP and gypsum
14. Estimation of Fe, Mn, Zn, and Cu in micronutrient mixture using Atomic absorption spectrophotometer
15. Detection of of adulterant in fertilisers
16. Visit to fertiliser testing laboratory
17. Record certification.

Reference

1. Das, D.K. 2003. Micronutrients. Their behaviour in soils and plants. Kalyani Publishers. New Delhi.
2. FAI. 1977. Hand Book on Fertiliser Technology. FAI Publication, New Delhi.
3. FAI. 1984. FertiliserControl Order. FAI Publication, New Delhi.
4. FAI. 1986. Hand Book on FertiliserUsage. FAI Publication, New Delhi.
5. Gupta, P.K. 2003. A Hand book of Soil, Fertilizers and Manures. Agrobios (India), Jodhpur.
6. John. L. Navlin, James D Beaton, Samuel L. Tisdale and Werner L. Nelson. 2003. Soil fertility and fertilizers – An introduction to nutrient management (6^{th} Edn.). Pearson Education (Singapore) Pvt. Ltd., New Delhi.
7. Tandon, H.L.S. (Ed.).2004. Fertilizers in Indian agriculture – from 20^{th} to 21^{st} Century. FDCO, New Delhi.
8. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 2002. Manures and Fertilisers (9^{th} Edn.). Agri-Horticultural Publishing House, Nagpur.

PGS 611 Research Methodology (0 + 1)
PGS 612 Basic Concepts in Laboratory Techniques (0+1)

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

Practical
Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings
Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press. Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co. 109

PGS 622 Technical Writing and Communications Skills (0+1)

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

Practical
Technical Writing **-** Various forms of scientific writings - theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, 107review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.
Communication Skills **-** Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols

and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

1. *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India. *Collins' Cobuild English Dictionary*. 1995. Harper Collins.
2. Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.
3. Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
4. James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
5. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
6. Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
7. Richard WS. 1969. *Technical Writing*. Barnes & Noble.
8. Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek.
9. Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
10. Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

PGS 623 Intellectual Property and its Management in Agriculture (1+0)
(e-Course)

Objective

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

Theory

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

Agriculture; Licensing of technologies, Material 108 transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

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

PGS 714 Library and Information Services (0+1)

Objective

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

Practical

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

PGS 725 Disaster Management (1+0)
(e-Course)

Objectives

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

Theory

UNIT I

Natural Disasters - Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, 110 volcanic eruptions, Heat and cold waves, Climatic change: Global warming, Sea level rise, Ozone depletion

UNIT II

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

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations and media. Central,

state, district and local administration; Armed forces in disaster response; Disaster response: Police and other organizations.

Suggested Readings

1. Gupta HK. 2003. *Disaster Management*. Indian National ScienceAcademy. Orient Blackswan.
2. Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.
3. Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.