



जननायक चन्द्रशेखर विश्वविद्यालय, बलिया-277001 (उ.प्र.)
Jananayak Chandrashekhar University, Ballia-277001 (U. P.)



FACULTY OF AGRICULTURE

COURSE STRUCTURE FOR

M.Sc.(Agriculture)

**AGRICULTURAL CHEMISTRY AND SOIL SCIENCE
UNDER SEMESTER SYSTEM**

ACADEMIC SESSION -2018-19



M.Sc.(Agriculture)

AGRICULTURAL CHEMISTRY AND SOIL SCIENCE

FACULTY OF AGRICULRE

SEMESTER SYSTEM

FACULTY OF AGRICULRE
M.Sc. (Agriculture)
AGRICULTURAL CHEMISTRY AND SOIL SCIENCE
SEMESTER SYSTEM

Course Structure for
M.Sc. (Agriculture) Agricultural Chemistry and Soil Science
Under Semester System to come into force from Academic Session 2018-19

M.Sc. (Ag) Agricultural Chemistry and Soil Science semester system

Study of soils' is the key to understand how an ecosystem works. Soil is a store house of water and nutrients to plants, filter for effluents-wastes, home to organisms, and is critical for recycling elements vital for plant growth, as well as organic and inorganic wastes. Moreover, soil is act as physical support to life. Soil management is essential in our continued quest to increase the production of food, fodder, fiber, fuel and fertilizers while maintaining and improving the environment, and mitigating the effects of climate change. Being the essence of all terrestrial life and ecosystem services, we cannot take the soils for granted. Soil is the foundation of survival for present and future generations. Due to overexploitation of soil resource for different purposes by the society, soil is undergoing several degradation processes, putting the soil quality at a stake, and threatening the sustainability of food productivity globally. It is nearly impossible to feed burgeoning population without maintaining soil health. Soil professionals have an important role to play in optimally managing soil resources. The Soil Scientists and soil professionals continue to enrich the lives of all human beings by improving stewardship of the soil, combating soil degradation, and ensuring the future protection and sustainable use of our air, soil, and water resources. We never think good agriculture without good soils? The future of all life is directly linked to our understanding and appreciation of soil and land management. However, new topics and also new courses have been added to new blood in the area. So, **THERE ISNO SOIL WITHOUT LIFE AND NO LIFE WITHOUT SOIL.**

- All the courses have been designed and updated as per present and future needs.
- New courses have been introduced to keep pace with the latest developments.
- List of books and Journals have been provided to keep pace with latest developments in the area.
- Suggested Areas of research have also been added for providing directions to the area

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

COURSE STRUCTURE – FIRST SEMESTER **M.M.: 400**

PAPER– 101 SOIL PHYSICS	75 MARKS
PAPER– 102 SOIL FERTILITY AND FERTILIZER USE	75 MARKS
PAPER– 103 SOIL CHEMISTRY	75 MARKS
PAPER– 104 INSTRUMENTAL AND ANALYTICAL METHODS OF SOIL AND PLANT ANALYSIS	75 MARKS
PRACTICAL FOR ALL	100 MARKS

COURSE STRUCTURE –SECOND SEMESTER **M.M.: 400**

PAPER – 201 SOIL EROSION AND CONSERVATION	75 MARKS
PAPER – 202 SOIL BIOLOGY AND BIOCHEMISTRY	75 MARKS
PAPER – 203 STATISTICS OF SOIL SCIENCE	75 MARKS
PAPER – 204 REMOTE SENSING AND GIS TECHNIQUES FOR SOIL AND CROP STUDIES	75 MARKS
PRACTICAL FOR ALL	100 MARKS

COURSE STRUCTURE – THIRD SEMESTER **M.M.: 400**

PAPER – 301 SOIL MINERALOGY, GENESIS, SURVEY AND CLASSIFICATION	75 MARKS
PAPER – 302 MANAGEMENT OF PROBLEMATIC SOILS AND WATER	75 MARKS
PAPER – 303 RADIOISOTOPES IN SOIL AND PLANT STUDIES	75 MARKS
PAPER – 304 FERTILIZER AND BIOFERTILIZER TECHNOLOGY	75 MARKS
PRACTICAL FOR ALL	100 MARKS

COURSE STRUCTURE – FOURTH SEMESTER **M.M.: 400**

PAPER – 401 ENVIRONMENT AND SOIL, WATER, AIR POLLUTION	75 MARKS
PAPER – 402 SEMINAR	75 MARKS
PAPER – 403 THESES WORK FOR RESEARCH	150 MARKS VIVA- VOCE OF THESIS WORK FOR RESEARCH
	100 MARKS

OR

SPECIAL PAPER (A+B)

PAPER – 403 A- SPECIAL PAPER-GEOMORPHOLOGY AND SYSTEM APPROACHES IN SOIL AND CROP STUDIES	75 MARKS
PAPER – 403 B- SPECIAL PAPER–GEOCHEMISTRY, LAND DEGRADATION AND RESTORATION	75 MARKS
PRACTICAL FOR SPECIAL PAPERS	100 MARKS

PROPOSED REGULATIONS

Semesters/Papers SEMESTER I	Title of the papers	Theory		Practical	
		Max. Marks	Min. Marks	Max. Marks	Mini. marks
Paper 101	(Theory Paper)	75	25	-	
Paper 102	(Theory Paper)	75	25	-	
Paper 103	(Theory Paper)	75	25	-	
Paper 104	(Theory Paper)	75	25	-	
	PRACTICAL FOR ALL			100	33
Total aggregate of First Semester is 36%		Max. Marks – 400 Min. Marks – 144			
SEMESTER II					
Paper 201	(Theory Paper)	75	25	-	
Paper 202	(Theory Paper)	75	25	-	-
Paper 203	(Theory Paper)	75	25	-	-
Paper 204	(Theory Paper)	75	25	-	-
	PRACTICAL FOR ALL	-	-	100	33
Total aggregate of First Semester is 36%		Max. Marks – 400 Min. Marks – 144			
SEMESTER III					
Paper 301	(Theory Paper)	75	25	-	-
Paper 302	(Theory Paper)	75	25	-	-
Paper 303	(Theory Paper)	75	25	-	-
Paper 304	(Theory Paper)	75	25	-	-
	PRACTICAL FOR ALL	-	-	100	33
Total aggregate of First Semester is 36%		Max. Marks – 400 Min. Marks – 144			
SEMESTER IV					
Paper 401	(Theory Paper)	75	25	-	-
Paper 402	SEMINAR	-		75	25
Paper 403	THESIS WORK FOR RESEARCH			150	50
	VIVA-VOCE OF THESIS WORK FOR RESEARCH			100	33
OR	OR				
	SPECIAL PAPER A	75	25	-	-
Paper 403 A	SPECIAL PAPER B	75	25	-	-
Paper 403B	PRACTICAL OF SPECIAL PAPERS			100	33
Total aggregate of First Semester is 36%		Max. Marks – 400 Min. Marks – 144			

Consolidate Performa for allotments of all semester are as follows-

First Semester	400	144
Second Semester	400	144
Third Semester	400	144
Fourth Semester	400	144
Grand Total	1600	576

Note-

1. The research work may be initiated in any of II or III semester but the thesis shall be submitted at the end of IV semester.
2. The evaluation of seminar presentation shall be done by the departmental committee which shall be constituted by the Head of Department /Principal of College.
3. Thesis work for research shall be 150 marks and 100 marks for viva-voce of thesis work, instead of thesis work, two optional papers will be offer for each 75 marks and 100 marks for their practical. Practical examination shall be conducted by external and internal examiner.
4. The thesis evaluation and viva-voce shall be made by the external and internal examiner.
5. The minimum passing marks of every paper shall be 33 % in theory and practical separately and total aggregate of the semester shall be 36 % minimum.

FACULTY OF AGRICULRE**M.Sc. (Ag.) Agricultural Chemistry and Soil Science****COURSE CONTENTS– DETAILED SYLLABUS****FIRST SEMESTER****PAPER – 101 SOIL PHYSICS****MAX.MARKS: 75****UNIT I**

Scope of soil physics and its relation with other branches of soil science; soil as a threephase system. Soil texture, textural classes, mechanical analysis. Soil consistence; dispersion and workability of soils, soil density, soil colour.

UNIT II

Soil structure - genesis, types, characterization and management; soil aggregation, soil tilth, soil crusting –mechanism; puddling, clod formation. Soil compaction, soil strength; swelling and shrinkage.

UNIT III

Soil water: content and potential, retention, soil-water constants, measurement of soil water, soil-moisture characteristic curve; water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hysteresis, hydraulic conductivity, permeability of soil. Drainage, Infiltration; evaporation; hydrologic cycle, soil-plant-atmosphere continuum.

UNIT IV

Composition of soil air; renewal of soil air, diffusion; measurement of soil aeration; aeration requirement and management for plant growth. Energy transfer in soils; energy balance; thermal properties of soil; measurement; soil temperature in relation to plant growth and management.

Practical

- Measurement of soil density
- Mechanical analysis by pipette and international methods
- Aggregate analysis - dry and wet, Soil temperature measurement by different methods
- Measurement of soil-water content and potential by different methods using tensiometer

- Determination of soil-moisture characteristics curve and computation of pore-size distribution
- Determination of infiltration rate, aeration, porosity and oxygen diffusion rate of soil

Suggested Readings

- Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.
- Ghildyal BP & Tripathi RP. 2001. *Soil Physics*. New Age International.
- Hillel D. 1980. *Applications of Soil Physics*. Academic Press.
- Hillel D. 1998. *Environmental Soil Physics*. Academic Press.
- Hillel D. 2003. *Introduction to Environmental Soil Physics*. Academic Press.
- Indian Society of Soil Science. 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
- Kohnke H. 1968. *Soil Physics*. McGraw Hill.
- Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
- Oswal MC. 1994. *Soil Physics*. Oxford & IBH.
- Saha A.K. 2004. *Text Book of Soil Physics*. Kalyani.

PAPER – 102 SOIL FERTILITY AND FERTILIZER USE

MAX.MARKS:75

UNIT I

Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms. Law of soil fertility soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation; nitrogenous fertilizers and their fate in soils; management of nitrogenous fertilizers.

UNIT II

Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting on availability in soils; phosphatic fertilizers -behavior in soils and management under field conditions. Potassium - forms, equilibrium in soils and its significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

UNIT III

Sulphur, Calcium and Magnesium- source, forms, fertilizers and their behavior in soils; factors affecting their availability in soils; management of 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.

UNIT IV

Fertilizer use efficiency; blanket fertilizer recommendations and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management. Common soil test methods for fertilizer recommendations; quantity– intensity relationships; DRIS, soil test crop response. Soil fertility evaluation, tests; soil quality in relation to sustainable agriculture.

Practical

- Soil organic matter content
- Chemical analysis of soil for total and available plant nutrients
- Flame-photometry and atomic absorption spectroscopy
- Principles of colorimetry
- Analysis of plants for essential elements

Suggested Readings

- Kabata-Pendias A & Pendias H. 1992. *Trace Elements in Soils and Plants*. CRC Press.
- Kanwar, J.S. (1985) *Theory and Practice of Soil Fertility*. ICAR Pub.
- Mengel K & Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.
- 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.
- Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.
- 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.
- Chand, S. (2008). *Integrated Nutrient Management for Sustainable Crop Production and Soil Health*, International Book Distributing Co., Lucknow, UP

PAPER – 103 SOIL CHEMISTRY

MAX.MARKS: 75

UNIT I

Chemical (elemental) composition of the earth's crust and soils. Elements of equilibrium thermodynamics, chemical equilibrium, electrochemistry and chemical kinetics.

Soil organic matter – classification, fractionation of soil organic matter and different fractions, genesis and nature of soil organic matter and humus formation, humus decomposition, separation of humus from soil particles, clay-organic interactions. The soil polysaccharides

UNIT II

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, flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids.

UNIT III

Ion exchange processes in soil; cation exchange- theories based on law of mass action adsorption isotherms, donnan-membrane equilibrium concept, AEC, CEC. Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibrium; step and constant-rate K; management aspects.

UNIT VII

Chemistry of acid soils; active and potential acidity; lime potential, sub-soil acidity. Chemistry of salt-affected soils and amendments; soil pH, E_{ce}, ESP, SAR and important relations; soil management and amendments. Chemistry and electrochemistry of waterlogged soils.

Practical

- Determination of CEC and AEC of soils
- Analysis of equilibrium soil solution for pH, EC, Eh by pH meter and conductivity meter
- Potentiometric and conductometric titration of soil humic and fulvic acids

- Humus study by visible spectrophotometric studies and the (E4/E6) values at two pH values
- Determination of titratable acidity of an acid soil by BaCl₂-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

Suggested Readings

- Bear RE. 1964. *Chemistry of the Soil*. Oxford and IBH.
- Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.
- Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.
- Greenland DJ & Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.
- McBride MB. 1994. *Environmental Chemistry of Soils*. Oxford Univ. Press.
- Spósito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ. Press.
- Spósito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.
- Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.
- Tan, K.H. 1988 *Principles of Soil Chemistry*, John Wiley & Sons.
- Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.
- Tolunur, Shivanandan (2006). *Soil Chemistry*, International Book Distributing Co. Lucknow

PAPER– 104 INSTRUMENTAL AND ANALYTICAL METHODS OF SOIL AND PLANT ANALYSIS

MAX.MARKS:75

UNIT I

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

UNIT II

Principles of visible, ultraviolet and infrared spectrophotometry, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, X-ray diffractometry; identification of minerals by different methods. Estimation of phosphorus, ammonium and potassium fixation capacities of soils.

UNIT III

Electrochemical titration of clays; Principles of 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 essential elements;

UNIT IV

Determination of lime and gypsum requirement of soil; drawing normalized exchange isotherms; measurement of redox potential. Analysis of soil extracts and irrigation waters for their soluble cation and anions and interpretation of results.

Suggested Readings

- Hesse P. 1971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons.
- Jackson, M.L. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
- Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.

- Page, A.L., Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
- Piper CS. *Soil and Plant Analysis*. Hans Publ.
- Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis – A Methods Manual*. IARI, New Delhi.
- Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.
- Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Waters*. FDCO, New Delhi.
- Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.
- ICAR Pesticide Residue Analysis Manual (Edition 2013), ICAR PUB.
- Chatwal, G. and Anand (2005). *Instrumental Methods of Chemical Analysis*, Academic Press

PRACTICAL FOR ALL

MAX.MARKS : 100

SECOND SEMESTER

PAPER – 201 SOIL EROSION AND CONSERVATION

MAX.MARKS: 75

UNIT I

History, distribution, identification and description of soil erosion problems in India. Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; factors affecting water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

UNIT II

Wind erosion- types, mechanism and factors affecting; extent of problem in the country. Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.

UNIT III

Soil conservation planning; land capability and irrigability: classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

UNIT IV

Watershed management- concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical

- Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio.
- Computation of kinetic energy of falling rain drops
- Computation of rainfall index (EI30) using rain gauge data
- Visits to a watershed

Suggested Readings

- Biswas TD & Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Society of Soil Science No. 17.

- Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Spl Publ. No. 49, Madison, USA.
- Gurnal Singh, Venkataramanan C, Sastry G & Joshi BP. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.
- Hudson N. 1995. *Soil Conservation*. Iowa State Univ. Press.
- Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
- Morgan, R.P.C. (1996). *Soil Erosion and Conservation*, Longmans, Harlow

PAPER – 202 SOIL BIOLOGY AND BIOCHEMISTRY

MAX.MARKS :75

UNIT I

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; rhizosphere, soil enzymes and their importance; soil characteristics influencing growth and activity of micro-flora.

UNIT II

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues. cycles of important nutrients.

UNIT III

Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil; microbial toxins in the soil. Cycles of important nutrients.

UNIT IV

Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost, biodynamic compost. Biofertilizers – definition, classification, specifications, method of production and role in crop production.

Practical

- Determination of soil microbial population
- Soil microbial biomass
- Elemental composition, fractionation of organic matter and functional groups
- Decomposition of organic matter in soil
- Soil enzymes
- Measurement of important soil microbial processes such as ammonification, nitrification, N₂ fixation, S oxidation, P solubilization and mineralization of other micro nutrients
- Study of rhizosphere effect

Suggested Readings

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

- SubbaRao. N.S. 2004 Soil Microbiology, Oxford & IBH.
- Stotzky G & Bollag JM. 1993. *Soil Biochemistry*. Vol. VIII. Marcel Dekker.
- Sylvia DN. 2005. *Principles and Applications of Soil Microbiology*. Pearson Edu.
- Wild A. 1993. *Soil and the Environment - An Introduction*. Cambridge Univ. Press.
- Jenkinson, D.S. and Ladd, J.N. (1981) *Soil Biochemistry*, Marcel Dekker, New York

PAPER – 203 STATISTICS FOR SOIL SCIENCE

MAX.MARKS :75

UNIT I

Descriptive statistics: probability distributions, binomial, probability distributions of functions of random variables. Classification and tabulation of data. Diagrammatic and Graphical representations of research results. Sampling distributions of sample mean and sample variance from Normal population, aim, method. Normal distribution - marginal and conditional distributions.

UNIT II

Measurement of central tendency: median, mode and mean, geometric mean, harmonic mean, weighted mean and their computation. Measurement of dispersion – range, mean deviation, standard deviation and their computation. Test of significance - chi-Square, z , t and F distributions and their properties and inter relationships.

UNIT III

Distribution of quadratic forms. Regression and correlation rank correlation, Regression analysis, partial and multiple correlation and regression, linear and nonlinear relationship. Test of hypothesis, analysis of variance, partitioning of degrees of freedom. Mechanical errors. Soil Heterogeneity - choosing, measuring and coping.

UNIT IV

Analysis of variance; Basic principles of design of experiments, uniformity trials, size and shape of plots and blocks. Basic designs - completely randomized design, randomized block design and Latin square design; orthogonal Latin squares. Factorial experiments, confounding in symmetrical factorial experiments ($2n$ and $3n$ series), partial and total confounding. Missing plot technique; Split plot and Strip plot design; Sampling in field experiments.

Suggested Readings

- Rohatgi VK & Saleh AK Md. E. 2005. *An Introduction to Probability and Statistics*. 2nd Ed. John Wiley.
- Chakrabarti MC. 1962. *Mathematics of Design and Analysis of Experiments*. Asia Publ. House.
- Cochran WG & Cox DR. 1957. *Experimental Designs*. 2nd Ed. John Wiley.
- Dey A & Mukerjee R. 1999. *Fractional Factorial Plans*. John Wiley.
- John JA & Quenouille MH. (1977). *Experiments: Design and Analysis*. Charles & Griffin.
- Kempthorne, O. 1976. *Design and Analysis of Experiments*. John Wiley.
- Khuri AI & Cornell JA. (1996) *Response Surface Designs and Analysis*. 2nd Ed. Marcel Dekker.
- Montgomery DC. (2005). *Design and Analysis of Experiments*. John Wiley.
- Raghavarao D. (1971). *Construction and Combinatorial Problems in Design of Experiments*. John Wiley.
- Design Resources Server. Indian Agricultural Statistics Research Institute (ICAR), New Delhi-110012, India. www.iasri.res.in/design.

- Gomez, K.A. and Gomez, A.A. (1984) Statistical Procedure for Agricultural Research, John Wiley and Sons
- Panse, V.G. and Sukhatme, P.V. (1985) Statistical Methods for Agricultural Workers, ICAR Pub.
- Chandel, S.R.S. (2006) A Hand Book of Agricultural Statistics, Achal Prakashan Mandir, Kanpur

PAPER – 204 REMOTE SENSING AND GIS TECHNIQUES FOR SOIL AND CROP STUDIES
MAX. MARKS: 75

UNIT I

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter.

UNIT II

Sensor systems - camera, microwave radiometers and scanners; fundamentals of aerial photographs and image processing and interpretations.

UNIT III

Application of remote sensing techniques - land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, Westland identification and management.

UNIT IV

Introduction to GIS and its application for spatial and non-spatial soil and land attributes. Significance and sources of the spatial and temporal variability in soils and sampling size; classical and geo-statistical techniques of evolution of soil variability.

Practical

- Familiarization with different remote sensing equipments and data products
- Interpretation of aerial photographs and satellite data for mapping of land resources
- Analysis of variability of different soil properties with classical and geostatistical techniques
- Creation of data files in a database programme
- Use of GIS for soil spatial simulation and analysis
- To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning

Suggested Readings

- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- Elangovan K. 2006. *GIS Fundamentals, Applications and Implementations*. New India Publ. Agency.
- Lillesand TM & Kiefer RW. 1994. *Remote Sensing and Image Interpretation*. 3rd Ed. Wiley.
- Nielsen DR & Wendroth O. 2003. *Spatial and Temporal Statistics*. Catena Verlag GmbH.
- Star, J. and Esles, J. 1990. *Geographic Information System: An Introduction*. Prentice Hall.

PRACTICAL FOR ALL

MAX. MARKS : 100

THIRD SEMESTER

PAPER – 301 SOIL MINERALOGY, GENESIS, SURVEY AND CLASSIFICATION

MAX. MARKS: 75

UNIT I

Fundamentals of crystallography, coordination theory, isomorphism and polymorphism; fundamental of pedology and edaphology; genesis and transformation of crystalline and non-crystalline clay minerals; clay minerals in Indian soils.

UNIT II

Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral and transformations; soil profile; Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil mineralogy and soil maps – usefulness.

UNIT III

Soil survey and types; survey techniques - conventional and modern; soil series –characterization and procedure for establishing; benchmark soils of India; soil surveysoil mapping, interpretations; thematic soil maps, cartography and techniques for generation of soil maps.

UNIT IV

Landform – soil relationship; major soil groups of India with special reference to respective states; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes in the agro-ecosystem.

Practical

- Identification and quantification of minerals in soil fractions
- 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
- Land use planning exercises using conventional and RS tools

Suggested Readings

- Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.
- Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.
- Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.
- Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi
- Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.
- USDA. 1999. *Soil Taxonomy*. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.
- Wilding LP & Smeck NE. 1983. *Pedogenesis and Soil Taxonomy: II. The Soil Orders*. Elsevier.
- Wilding NE & Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy. I. Concept and Interaction*. Elsevier.
- Soil Survey Field Book (1995) NBSS& LUP

- Soil Survey Manual (1995) NBSS&LUP

PAPER – 302 MANAGEMENT OF PROBLEMATIC SOILS AND WATER MAX. MARKS: 75

UNIT I

Area and distribution of problematic soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils and factors responsible.

UNIT II

Chemistry and Morphological features of saline, sodic and saline-sodic soils; characterization of salt affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties.

UNIT III

Management of salt-affected soils; salt tolerance of crops - mechanism and ratings; management and monitoring of soil salinity in the field. Acid soils-nature of soil acidity, sources and effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management; soil conditioners.

UNIT IV

Quality of irrigation water; management of brackish water for 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. Management principles for sandy, clayey, red lateritic and dry land soils.

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^- , SO_4^{--} , CO_3^{--} and HCO_3^-) in ground waters and soil samples
- Lime and gypsum requirements of acid and sodic soils

Suggested Readings

- Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.
- Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.
- USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.
- Acid Soil of India (1995) ICAR Publication

PAPER – 303 RADIOISOTOPES IN SOIL AND PLANT STUDIES MAX.MARKS:75

UNIT I

Atomic structure, radioactivity and units; radioisotopes - properties and decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter

UNIT II

Principles and use of radiation monitoring instruments - proportional, Geiger Muller counters, solid and liquid scintillation counters; neutron moisture meter. Mass spectrometry

UNIT III

Isotopic dilution techniques used in soil and plant research; use of stable isotopes; application of isotopes in studies on organic matter, nutrient transformations, ion transport, rooting pattern and fertilizer use efficiency; carbon dating.

UNIT IV

Doses of radiation exposure, radiation safety aspects regulatory aspects, collection, storage and disposal of radioactive wastes

Practical

- Storage and handling of radioactive materials
- Preparation of soil and plant samples for radioactive measurements
- Setting up of experiment on fertilizer use efficiency and cation exchange equilibria using radioisotopes
- Determination of A, E and L values of soil using ^{32}P / ^{65}Zn
- Use of neutron probe for moisture determination
- Sample preparation and measurement of ^{15}N enrichment by mass spectrophotometry/ emission spectrometry

Suggested Readings

- Comer CL. 1955. *Radioisotopes in Biology and Agriculture: Principles and Practice*. Tata McGraw Hill.
- Glasstone S. 1967. *Source Book on Atomic Energy*. East West Press.
- Michael FL & Annunziata. 2003. *Handbook of Radioactivity Analysis*. Academic Press.
- Subbiah, B.V., Das, B.K., Sachdev, M.S. (1994) *Isotopes in Soil-Plant Nutrition*, ICAR Pub.
- Vose, P.B. (1980) *Introduction to Nuclear Techniques in Agronomy and Plant Biology*, Oxford Pergamon Press, London

PAPER – 304 FERTILIZERS AND BIOFERTILIZER TECHNOLOGY MAX. MARKS: 75

UNIT I

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 development in primary nutrient fertilizers their quality control and technology of manufacturing.

UNIT II

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, super granules fertilizers and fertilizers for specific crops/situations.

UNIT III

Biofertilizers industries in India; Classification, growth and nutrition of soil organism as micro and macro organisms. Association and antagonistic activities of micro-organisms in biofertilizers.

UNIT IV

Technology of bio fertilizers-Bacterial biofertilizers, fungi based biofertilizers, actinomycetes based bio fertilizers, Algae based biofertilizers. Quality control, storage and transportation. Biotechnological approaches of biofertilizers development; Microbial products and plant growth. Organic farming and sustaining soil health in India for food and nutritional security.

Practical

Test the viability of biofertilizers

Isolation and preparation of culture as broth and agar media culture

Maintain of strain of microorganisms

Quality test of biofertilizers

Measurement of important soil microbial processes in biofertilizers as ammonification, N₂ fixation, S oxidation, P solubilization

Determination NPKS in Different fertilizers

Determination of compatibility of fertilizers

Determination adulteration of fertilizers

Suggested Readings

- Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ.
- Posen, M.E. 1989 *Fertilizers Technology*, Academic Press
- Basak, R.K. (2000) *Fertilizers- A Text Book*, Kalyani Publishers
- Das. P.C. (2003) *Manures and Fertilizers*, Kalyani Publishers
- *Hand Book of Fertilizers Technology* (2005) FAI Publication
- SubbaRao, N.S. 2004 *Soil Microbiology* Oxford & IBH.
- ICAR 2005 *Biofertilizers and Sustainable Agriculture*
- M. Alexander 1983 *Soil Microbiology* Oxford & IBH
- Prasad, MNV, Sajwan, KS and Naidu, R. (2006) *Trace Elements in Environment : Biochemistry and Bioremediation*, CRC Press
- *Bacterial Fertilizers* 1996. ICAR Pub.
- *Biological Nitrogen Fixation* 1998 ICAR Pub.

PRACTICAL FOR ALL

MAX. MARKS: 100

FOURTH SEMESTER

PAPER-401 ENVIRONMENT AND SOIL, WATER, AIR POLLUTION-MAX. MARKS: 75

UNIT I

Environment, segment of environment, problems associated with agriculture, nature and extent, soil ecology and soil health, agro-biodiversity, disaster, environment and public health.

UNIT II

Soil, water and air pollution: nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.

UNIT III

Sewage and industrial effluents – their composition and effect on soil properties/health and plant growth and human beings; Pesticides – their classification, behavior in soil and effect on soil microorganisms. Geochemical toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

UNIT VI

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; remote sensing applications in monitoring and management of soil and water pollution. Biochemical effect of As, Cd, Hg, Pb, nitrogen oxide, sulphur oxide and pesticides.

Practical

- Sampling of sewage waters, sludge, solid/liquid industrial wastes, polluted soils and plants
- Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in effluents
- Heavy metals in contaminated soils and plants
- Management of contaminants in soil and plants to safeguard food safety
- Air sampling and determination of particulate matter and oxides of sulphur
- Visit to various industrial sites to study the impact of pollutants on soil and plants

Suggested Readings

- Lal R, Kimble J, Levine E & Stewart BA. 1995. *Soil Management and Greenhouse Effect*. CRC Press.
- Middlebrooks EJ. 1979. *Industrial Pollution Control*. Vol. I. *Agro-Industries*. John Wiley Interscience.
- Ross SM. *Toxic Metals in Soil Plant Systems*. John Wiley & Sons.
- Vesilund PA & Pierce 1983. *Environmental Pollution and Control*. Ann Arbor Science Publ.
- De, A.K. 2009 *Environmental Chemistry*, Academic Press.
- Banerjee, S.K. 2001, *Chemistry of Environment*, Academic Press.
- Mishra, P.C. (2001) *Soil Pollution and Soil Organisms*, Ashish Publishing House, New Delhi
- Lal, R. (2002) *Human, Society and Soil-Encyclopedia of Soil Science*, Marcel Dekkar New York.

PAPER – 402 SEMINAR

MAX.MARKS: 75

PAPER-403 THESIS WORK FOR RESEARCH

MAX.MARKS: 150

Suggested Broad Topics of thesis for Research Work

Related to agricultural chemistry and soil science which focus on soil fertility, soil biology, soil chemistry, soil physics, pedology, soil genesis, soil survey, environment as well as soil, water and air pollution and remediation, fertilizers and manure, compost and composting tracer techniques for soil, water and plant system, system approaches in soil and crop studies, radioisotopes in soil and plant studies, soil erosion and management, watershed and management, radioactive isotopes in relation to plant and soil, problem soils, water and their management, remote sensing and GIS techniques for soil, water and crop studies and natural resource, biofertilizer and their technology, geochemistry and geomorphology, fertilizer technology, fertilizer management, plant nutrition and remediation, land use and its planning, agricultural and crop residues/wastes and their management, soil quality, soil and organic farming, soil and society etc.

VIVA-VOCE OF THESIS WORK FOR RESEARCH

MAX.MARKS: 100

OR

PAPER -403 A+ 403B

PAPER – 403 (A) SPECIAL PAPER– GEOMORPHOLOGY AND SYSTEM APPROACHES IN SOIL AND CROP STUDIES

MAX. MARKS: 75

UNIT I

General introduction to geomorphology, major and minor morphogenic and genetic landforms, study of schematic landforms and their elements with special reference to India.

UNIT II

Systems concepts - definitions, general characteristics; general systems theory; systems thinking, systems dynamics, systems behavior and systems study. Simulation - meaning and threats, simulation experiment, its design and analysis.

UNIT III

Methodology of geomorphology, its agencies, erosion and weathering; soil and physiography relationships; erosion surface of soil landscape.

UNIT IV

Application of simulation models in understanding system behavior, optimizing system performance, evaluation of policy options under different soil, water, nutrient, climatic and cultural conditions; decision support system, use of simulation models in decision support system.

Practical

- Use of flow chart or pseudo-code in the program writing
- Writing a small example simulation model program - declarative (in Vensim PLE, Stella or Simile) and procedural (in Java, Fortran, QBasic or V Basic)
- Conducting simulation experiments in DSSAT, WOFOST or EPIC with requirement of Report and conclusion

Suggested Readings

- Brikland P.W. 1999. *Soils and Geomorphology*. 3rd Ed. Oxford Univ. Press.
- Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi
- Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.
- USDA. 1999. *Soil Taxonomy*. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.
- Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.
- Benbi DK & Nieder R. (Eds.). 2003. *Handbook of Processes and Modeling in the Soil - Plant System*. Haworth Press.
- Hanks J & Ritchie JT. (Eds.). 1991. *Modelling Plant and Soil System*.
- *Agronomy*. Bull. No 31. Soil Sci. Society of America, Madison.
- Rajaraman V. 2004. *Computer Programming in Fortran 90 and 95*. PHI.
- Tsuji GY, Gerrit H & Philip T. 1998. *Understanding Options for Agricultural Production*. Kluwer.
- Von Bertalanffy Ludwig 1969. *General Systems Theory: Foundation Development and Application*. Revised Ed. George Braziller Reprint 1998.

PAPER – 403 (B) SPECIAL PAPER–GEOCHEMISTRY AND LAND DEGRADATION AND RESTORATION

MAX.MARKS :75

UNIT I

General introduction to geology and geochemistry, study of schematic landforms and their elements with special reference to India.

UNIT II

Type, factors and processes of soil/land degradation and its impact on soil productivity, including soil fauna, biodegradation and environment. Land restoration and conservation techniques - erosion control, reclamation of salt affected soils; mine land reclamation, afforestation, organic products.

UNIT III

Geochemical classification of elements; geo-chemical aspects of weathering and migration of elements; geochemistry of major and micronutrients and trace elements.

UNIT IV

Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools; monitoring land degradation by fast assessment, modern tools, land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.

Suggested Readings

- Likens G.E. & Bormann F.H. 1995. Geochemistry. 2nd Ed. Springer Verlag.
- Mortvedt J.J., Shuman LM, Cox, F.R. & Welch RM. 1991. Micronutrients in Agriculture.
- Brady NC & Weil RR. 2002. The Nature and Properties of Soils. Pearson Edu.
- Fertilizer (Control) Order, 2010 and the Essential Commodities Act. FAI New Delhi.
- Kanwar J.S. (Ed.). 1976. Soil Fertility: Theory and Practice. ICAR.
- Olson RA, Army TS, Hanway JJ & Kilmer VJ. 1971. Fertilizer Technology and Use. 2nd Ed. Soil Sci. Soc. Am. Madison.
- Prasad R & Power JF. Soil Fertility Management for Sustainable Agriculture. CRC Press.
- Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. Soil Fertility and Fertilizers. McMillan Publ.
- Vogel AI. 1979. Textbook of Quantitative Inorganic Analysis. ELBS.
- Biswas TD & Narayanasamy G. (Eds.). 1996. Soil Management in Relation to Land Degradation and Environment. Bull. Indian Soc. Soil Sci. 17, New Delhi.
- Doran JW & Jones AJ. 1996. Methods of Assessing Soil Quality. Soil Science Society of America, Madison.
- Greenland DJ & Szabolcs I. 1994. Soil Resilience and Sustainable Land Use. CABI.
- Lal R, Blum WEH, Vailentine C & Stewart BA. 1997. Methods for Assessment of Soil Degradation. CRC Press.
- Sehgal J & Abrol I.P. 1994. Soil Degradation in India - Status and Impact. Oxford & IBH.
- Soils of India and Their Management (1985) FAI Publication

PRACTICAL FOR SPECIAL PAPERS

MAX. MARKS: 100

Suggested Broad Topics for Master's and Doctoral Research

- Degradation and restoration of soil as natural resource
- Biochemistry of processes at the soil-root interface
- Impact of current agricultural practices and agrochemicals on soil quality/biodiversity
- Integrated nutrient management for sustainable agriculture
- Fertilizer use efficiency in different soil conditions/cropping systems
- Use of remote sensing and GIS as diagnostic tool for natural resource management

- Role of biological agents in soil productivity
- Modeling solute (salt, fertilizer, pesticides) transport in soil
- Use of poor quality waters in Agriculture
- Soil testing and crop response
- Site-specific nutrient management and precision agriculture
- Nutrient dynamics in soil-plant system and modeling nutrient uptake
- Tillage and crop residue management in crop production
- Utilization of urban and industrial wastes/effluents in Agriculture
- Management of problematic soils
- Impact of climate change on soil processes
- Micronutrients in soil, plant and human health
- Water management strategies in different cropping systems
- Simulation models for growth and production of different crops
- Varietals response to soil salinity/ sodicity/ nutrients/ pollutants, etc
- Soil and water pollution - monitoring and control
- Genesis, formation and classification of soils
- Soil conservation, preservation and management for sustainable agriculture
- Remediation of polluted and contaminated soils

Suggested Books

1. *Agronomy*. Bull. No 31. Soil Sci. Society of America, Madison.
2. Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons. America, Madison.
3. *Environmental Management*. Marcel Dekker.
4. Barber SA. 1995. *Soil Nutrient Bioavailability*. John Wiley & Sons.
5. Barker V Allen & Pilbeam David J. 2007. *Handbook of Plant Nutrition*.
6. Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley &
7. Bear RE. 1964. *Chemistry of the Soil*. Oxford & IBH.
8. Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
9. Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.
10. Boul SW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.
11. Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed.
12. Brewer R. 1976. *Fabric and Mineral Analysis of Soils*. John Wiley & Sons.
13. Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
14. Cooke GW. 1979. *The Control of Soil Fertility*. Crosby Lockwood &
15. Design Act, 2000; PPV and FR Act 2001, and Rules 2003;
16. National Biological Diversity Act, 2003.
17. *Development and Application*. Revised Ed. George Braziller
18. Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil
19. Epstein E. 1987. *Mineral Nutrition of Plants - Principles and Perspectives*.
20. FAO. 1976. A Framework for Land Evaluation, Handbook 32. FAO.
21. *Fertilizer (Control) Order, 1985 and the Essential Commodities Act*. FAI
22. Fried M & Broeshart H. 1967. *Soil Plant System in Relation to Inorganic Nutrition*. Academic
23. Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
24. Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.
25. Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
26. Gieseking JE. 1975. *Soil Components*. Vol. 1. Organic Components. Springer-Verlag.

27. Greenland DJ & Hayes MHB. 1978. *Chemistry of Soil Constituents*. John Wiley & Sons.
28. Greenland DJ & Szabolcs I. 1994. *Soil Resilience and Sustainable Land*
29. Gupta HK. 2003. *Disaster Management*. Indian National Science Academy.
30. Hanks and Ascheroff. 1980. *Applied Soil Physics*. Springer Verlag.
31. Hanks J & Ritchie JT. (Eds.). 1991. *Modelling Plant and Soil System*.
32. Hillel D. 1980. *Applications of Soil Physics*. Academic Press.
33. Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.
34. Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
35. Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS,
36. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
37. International Potash Institute, Switzerland.
38. James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
39. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
40. Jurinak JJ. 1978. *Chemistry of Aquatic Systems*. Dept. of Soil Science & Biometeorology, Utah State Univ.
41. Kabata- Pendias Alina 2001. *Trace Elements in Soils and Plants*. CRC /
42. Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers*
43. Kanwar JS. (Ed.). 1976. *Soil Fertility: Theory and Practice*. ICAR.
44. Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley
45. Kristiansen P, Taji A & Reganold J. 2006. *Organic Agriculture: A Global Perspective*. CSIRO Publ.
46. Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
47. Lillesand TM & Kiefer RW. 1994. *Remote Sensing and Image Interpretation*
48. Magdoff F & Weil RR 2004. *Soil Organic Matter in Sustainable Agriculture*. CRC Press.
49. McBride MB. 1994. *Environmental Chemistry of Soils*. Oxford Univ. Press.
50. McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel
51. Mercky R & Mulongoy K. 1991. *Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture*. John Wiley & Sons.
52. Metting FB. 1993. *Soil Microbial Ecology – Applications in Agricultural*
53. *Modelling in the Soil - Plant System*. Haworth Press.
54. Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
55. Nielsen DR & Wendroth O. 2003. *Spatial and Temporal Statistics*. Catena
56. Olson RA, Army TS, Hanway JJ & Kilmer VJ. 1971. *Fertilizer Technology*
57. Oswal MC. 1994. *Soil Physics*. Oxford & IBH.
58. Paul EA & Ladd JN. 1981. *Soil Biochemistry*. Marcel Dekker.
59. Paul EA. 1996. *Soil Microbiology and Biochemistry*. Academic Press.
60. Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable, CRC*
61. Punia, MS. *Manual on International Research and Research Ethics*. H A U, Hisar.
62. Rajaraman V. 2004. *Computer Programming in Fortran 90 and 95*. PHI.
63. Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
64. Reddy MV. (Ed.). *Soil Organisms and Litter in the Tropics*. Oxford & IBH.
65. Richard W.S. 1969. *Technical Writing*. Barnes & Noble.
66. Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
67. Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.
68. Sehgal J & Abrol IP. 1994. *Soil Degradation in India - Status and Impact*.
69. Sehgal JL, Mandal DK, Mandal C & Vadivelu S. 1990. *Agro-Ecological*

70. Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.
71. Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.
72. Soil Survey Staff 1998. Keys to Soil Taxonomy. 8th Ed. USDA & NRCS,
73. Sparks DL. 1999. Soil Physical Chemistry. 2nd Ed. CRC Press.
74. Sposito G. 1981. The Thermodynamics of Soil Solutions. Oxford Univ. Press.
75. Star J & Esles J. 1990. *Geographic Information System: An Introduction*.
76. Stevenson FJ. (Ed.). 1982. *Nitrogen in Agricultural Soils*. Soil Science
77. Stevenson FJ. 1994. Humus Chemistry – Genesis, Composition and Reactions. John Wiley & Sons.
78. Stotzky G & Bollag JM. 1993. *Soil Biochemistry*. Vol. VIII. Marcel
79. Sylvia DN. 2005. *Principles and Applications of Soil Microbiology*.
80. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000;
81. *the Soil*. ELBS & McGraw Hill.
82. Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1990. *Soil Fertility and*
83. *Land Degradation and Environment*. Bull. Indian Soc. Soil Sci.
84. Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout
85. Tsuji GY, Gerrit H & Philip T. 1998. *Understanding Options for*
86. USDA 1974. A Manual on Conservation of Soil and Water Handbook of
87. Vogel AI. 1979. *Textbook of Quantitative Inorganic Analysis*. ELBS.
88. Von Bertalanffy Ludwig 1969. *General Systems Theory: Foundation* Washington, DC.
89. Wild A. (Ed.). 1988. *Russell's Soil Conditions and Plant Growth*. 11th Ed.
90. Wild A. 1993. *Soil and the Environment - An Introduction*. Cambridge

AGRICULTURAL CHEMISTRY AND SOIL SCIENCE: LIST OF JOURNALS

- Advanced Soil Science
- Advances in Agronomy
- Aogochmemica
- Agriculture Science
- Agropedology
- Annals of Arid Zone
- Australian Journal of Agricultural Research
- Australian Journal of Soil Research
- Biology and Fertility of Soils
- Bioresource Technology Journal
- Canadian Journal of Soil Research
- Catena
- Clays and Clay minerals
- Clays Research
- Communications in Soil Science and Plant Analysis
- Current Microbiology
- Current Science
- Environmental Science and Technology
- European Journal of Soil Science
- Geoderma
- Indian Journal of Agricultural Sciences
- Indian Journals of Indigenous Technology
- Indian Journal of Fertilizers

- International Journal of Remote Sensing
- Journal of Environmental Quality
- Journal of Nuclear Agriculture Biology
- Journal of Plant Nutrition and Soil Science
- Journal of Potassium Research
- Journal of Progressive Science
- Journal of Soil and Water Conservation
- Journal of The Indian Society of Agricultural Chemists
- Journal of The Indian Society of Remote Sensing
- Journal of the Indian Society of Soil Science
- Nutrient Cycling in Agroecosystems
- Plant and Soil
- Soil and Tillage Research
- Soil Biology and Biochemistry
- Soil Science
- Soil Science Society of America Journal
- Soil Use and Management
- Water Pollution
- Water Resources Research
- Water, Air and Soil Pollution

