Course No: Soil 501
Credit hours: (2+1)
Course title: Soil Physics

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

Theory

UNIT I: Basic principles of physics applied to soils,soil as a three phase system.

UNIT II: Soil texture, textural classes, mechanical analysis, specific surface.

UNIT III: Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts.Alleviation of soil physical constraints for crop production. Soil erosion and edibility

UNIT IV: Soil structure - genesis, types, characterization and management soil structure; soilaggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soilphysical properties; clod formation.

UNIT V: Soil water: content and potential, soil water retention, soil-water constants,measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential.

UNIT VI: Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy'slaw;hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement ofhydraulic conductivity in saturated and unsaturated soils.

UNIT VII: Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle,field water balance; soil-plant-atmosphere continuum.

UNIT VIII: Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management.

UNIT IX: Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

Practical

•Determination of B.D, P.D and mass volume relationship of soil,Mechanical analysis by hydrometer and international pipette method,• Measurement of Atterberg limits, Aggregate analysis - dry and wet, Measurement of soil-water content by different methods, Measurement of soil-water potential by using tensiometer and gypsum Blocks,Determination of soil-moisture characteristics curve and computation of pore- size,distribution, Determination of hydraulic conductivity under saturated and unsaturated conditions, Determination of infiltration rate of soil, Determination of aeration porosity and oxygen diffusion rate,Soil temperature measurements by different methods,Estimation of water balance components in bare and cropped fields.

Teaching methods/activities: Classroom teaching with AV aids, group discussion, oralpresentation by students.

Learning outcome: Experience on the knowledge of soil physical properties and processes in relation to plant growth.

Suggested Read

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

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

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

1972. *Optimizing the Soil Physical Environment toward GreaterCrop Yields*.

Academic Press.

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

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

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

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

Course title: Soil fertility and fertilizer use
Course Code: Soil-502
Credit hours: 4(3+1)

OBJECTIVE

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

THEORY

UNIT I: Soil fertility and soil productivity; fertility status of major soils group of India; nutrient sources fertilizers and manures; Criteria of essentiality, classification, law of minimum and maximum, essential plant nutrients - functions and deficiency symptoms, Nutrient uptake, nutrient interactions in soils and plants; long term effect of manures and fertilizers on soil fertility and crop productivity;

UNIT II: Soil and fertilizer nitrogen — sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation -types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.

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

management of potassium fertilizers under field conditions.

UNIT IV: Sulphur - source, forms, fertilizers and their behavior in soils; role in crops and human health; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.

UNIT V: 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 VI: Common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions.

UNIT VIII: Fertilizer use efficiency; site-specific nutrient management; plant need based nutrient management; integrated nutrient management; speciality fertilizers concept, need and category. Current status of speciality fertilizers use in soils and crops of India;

UNIT IX: Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture, Determination of critical limit, DRIS

UNIT X: Definition and concepts of soil health and soil quality; Long term effects of fertilizers

and soil quality.

PRACTICAL

- Soil and plant sampling and processing for chemical analysis
- Determination of soil pH, total and organic carbon in soil
- Chemical analysis of soil for total and available nutrients(major and micro)
- Analysis of plants for essential elements(major and micro)

Course title: Soil Chemistry
Course No: Soil 503
Credit hours: (2+1)

OBJECTIVE

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

THEORY

UNIT I: Chemical (elemental) composition of the earth's crust, soils, rocks and minerals
UNIT II: Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.
UNIT III: Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, Characterization of OM; clay- organic interactions.

UNIT IV : Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption is otherms, Donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and lig and exchange –inner sphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresisin sorption-desorption of oxy-anions and anions, shift of PZC on lig and exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.
UNIT V: Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; Concept of quantity/intensity (Q/I) relationship; step and constant-rate K; management aspects.

UNIT VI: Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity.

UNIT VII: Chemistry of salt-affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments.

UNIT VIII: Chemistry and electrochemistry of submerged soils, geo chemistry of micronutrients, environmental soil chemistry

Practical

Preparation of saturation extract, measurement of pH, EC, CO, HCO, Ca, Mg, K and Na, Determination of CEC and AEC of soils, •Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter, Determination of point of zero- charge and associated surface charge characteristics by the serial potentio metric titration method

,Extraction of humic substances, Potentiometric and conducto metric titration of soil humic and fulvic acids,(E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and theΔ (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 titratable acidity of an acid soil by BaCl2-TEA method,Determination of Q/I relationship of potassium, Determination of lime requirement of an acid soil by buffer method, Determination of gypsum requirement ofan alkali soil.

Course title: Soil mineralogy, genesis and classification
Course No: Soil 504
Credit hours: (2+1)

OBJECTIVE

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

THEORY

UNIT I: Fundamentals of crystal lography, spacelattice, coordination theory, is omorphism and poly morphism.

UNIT II: Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystal line and non-crystal line clay minerals; identification techniques; amorphous soil constituents and other non- crystal inesilicate minerals and their identification; clay minerals in Indian soils, role of clay miner als in plant nutrition, interaction of clay with humus, pesticides and heavy metals.

UNIT III: Factors of soil formation, soil formation models; soil forming processes;weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

UNIT IV: Concept of soil individual; soil classification systems–historical developments and modern systems of soil classification with special emphasison soil taxonomy; soil classification, soil mineralogy and soil maps–usefulness.

PRACTICAL

- Separation of sand, silt and clay fraction from soil
- Determination of specific surface area and CEC of clay
- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different and forms
- Classification of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soils using available database interm of soil quality

Course title: Soil biology and biochemistry
Course No: Soil 506
Credit hours: (2+1)

OBJECTIVE

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

THEORY

UNIT I: Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial bio mass; microbial interactions; un-culturable soil biota.

UNIT II: Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora; Root rhizosphere and PGPR.

UNIT III: Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, microbiology and biochemistry of decomposition of carbonaceous and protenaceous materials, cycles of important organic nutrients.

UNIT IV: organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

UNIT V: Preparation and preservation of farm yard manure, animal manures, rural and urban composts and vermicompost.

UNIT VI: Biofertilizers–definition, classification, specifications, method of production and role in crop production; FCO specifications and quality control of biofertilizers.

UNIT VII: Biological indicators of soil quality; bio remediation of contaminated soils; microbial transformations of heavy metals in soil; role of soil organisms in pedogenesis—important mechanisms and controlling factors; soil genomics and bio prospecting; soil sickness due to biological agents; xenobiotics; antibiotic production in soil.

PRACTICAL

- Determination of soil microbial population
- Soil microbial bio mass carbon
- 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, N_2 fixation, Soxidation, Psolubilization and mineralization of other micro nutrients

Course No: Soil 508
Credit hours: (2+1)
Course title: Soil, water and air pollution

OBJECTIVE

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

THEORY

UNIT I: Soil, water and air pollution problems associated with agriculture, nature and extent.

UNIT II: Nature and sources of pollutants–agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oils pills etc.; 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, plant growth and human beings; soil as sink for waste disposal.

UNIT IV: Pesticides–their classification, behavior in soil and effect on soil micro-organisms.

UNIT V: 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 green house gases–carbon dioxide, methane and nitrous oxide.

UNIT VII: Risk assessment of polluted soil, Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

Practical

Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants and their processing, Estimation of dissolved and suspended solids, Chemical oxygen demand (COD),biological demand (BOD),measurement of coliform (MPN),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, NO2 and O2 conc. Visit to various industrial sites to study the impact of pollutants on soil and plants.

Course title: Remote sensing and GIS technique for soil, water and crop studies
Course No: Soil 509
Credit hours:(2+1)

OBJECTIVE:

To impart knowledge about the basic concepts of remote sensing, aerial photographs and imageries and the irinter pretation ; application of remote sensing in general and with special reference to soil, plants and yield forecasting; to impart knowledge about geo-statistical techniques with special reference to krigging, and GIS and applications in agriculture.

THEORY

UNIT I: Introduction and history of remote sensing; sources, propagation ofRadiations in atmosphere; interactions with matter, basic concepts and principles; hardware and software requirements; common terminologies of geographic information system(GIS).

UNIT II: Sensor systems-camera, micro wave radiometers and scanners; fundamentals of aerial photographs and multi spectral imaging, hyper spectral imaging, thermal imaging; image processing and interpretations.

UNIT III: Application of remote sensing techniques-land use soil surveys, crop stress and yield forecasting, prioritization in water shed and drought management, waste land identification and management.

UNIT IV: Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of soil variability.

UNIT V: Applications of GIS for water resources, agriculture, precision farming, disaster management, e-governance, Agricultural Research Information System (ARIS).

PRACTICAL

Familiarization with different remote sensing equipments and data products, Interpretation of aerial photo graphs and satellite data for mapping of land resources, Analysis of variability of different soil properties with classical and geo statistical techniques, Creation of data files in a database programme, use of GIS for soils partials imulation and analysis, to enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning.

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Course title: Analytical technique and instrumental methods in soil and plant analysis
Course No: Soil 510
Credit hours: (0+2)

PRACTICAL

UNIT I: Preparation of solutions for standard curves, indicators and standard solutions for acid-base, oxidation reduction and complex ometrictitration; soil, water and plant sampling techniques, their processing and handling.

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

UNIT III: Principles of visible, ultraviolet and infrared spectro photometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromate graphic techniques, masss pectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods, CHNS analyzer.

UNIT IV: Electro chemical titration of clays; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

UNIT V: Wet digestion/fusion/extraction of soil with aquaregia with soil for elemental analysis; triacid/ di-acid digestion of plant samples; determination of available and total nutrients (N,P ,K, S, Ca, Mg, Zn, Cu, Fe, Mn ,B, Mo) in soils; determination of tot al nutrients (N, P,K, S, Ca, Mg, Zn,Cu, Fe, Mn, B, Mo) in plants.

UNIT VI: Drawing normalized exchange is otherms; measurement of redox potential.