NAGALAND UNIVERSITY
(A Central University)
School of Agricultural Sciences & Rural Development
Medziphema: Campus - 797 106. Nagaland (India)
Department of Agricultural Chemistry and Soil Science

Syllabus of M.Sc. (Ag.)

ACS - 501 Soil Physics **(2+1)**

Theory

Soil is a disperse system, particle size distribution. Soil structure and its classification, genesis and significance in agriculture. Dynamic properties of soil consistency, soil plasticity, shearing, compression and penetration strength, tillage and tilth. Soil water, types of soil water, energy concept of soil water, soil water retention and movement in saturated and unsaturated conditions. Methods of measuring soil water, soil water loss, soil moisture terminologies and soil moisture indices, soil – water – plant atmosphere continuum. Effect of water on soil and crops. Soil aeration, composition of soil air, gaseous exchange, diffusion and its significance on growth. Soil erosion, factors affecting soil erosion, management and conservation of soil and water. Thermal regimes of soil, soil temperature in relation to plant growth.

Practical

Determination of particle size distribution. Bulk density, particle density, porosity, aggregate analysis, and consistency, measurement of soil moisture.

ACS - 502 Soil Fertility and Fertilizer Use **(2+1)**

Theory

Soil fertility concept, factors affecting soil fertility, essentialities of nutrients. Essential and beneficial elements. Mechanism of ion uptake, growth factors affecting it and growth expression. Occurrence, mineralization and transformation of native and applied nitrogen, phosphorus, potassium and sulphur. Principles of fertilizer application. Residual effects of fertilizers and organic manures. Soil testing for assessing nutrient requirements of crops. Critical limits nutrients and soil test crop response. Concept of straight, complex, liquid and slow release fertilizers. Fertilizer reaction products in soil, changes in soil fertility on long- term use of fertilizer.

Practical

Determination of NPK in soils. Analysis of plant material for nitrogen, phosphorus, potassium, calcium magnesium and sulphur. Determination of some important micro- nutrients.

ACS - 503 Soil Mineralogy, Genesis, Classification and Survey **(2+1)**

Theory

Concepts of soil genesis, factors of soil formation, pedogenic process of soil development, soil profile characteristics, horizon nomenclature and soil morphology. Soil survey- purpose and types of survey. Soil

classification-earlier system, genetic system, USDA soil taxonomy, diagnostic epipedons and endopedons, moisture and temperature regimes, categories of soil taxonomy. Soil groups of India and their placement in soil taxonomy. Remote sensing and its importance in agriculture. Concept of land use classification and mapping.

Practical

Study of soil profiles and preparation of field report. Soil survey and classification of different adjoining soil types.

ACS - 504 Soil Chemistry (2+1)

Theory

Chemical composition of soil, soil colloids origin, structure and properties. Isomorphous substitution, source of charges, Zeta potential, electric double layer and stability of clays. The effect of flocculation and dispersion on plant growth, ion exchange reactions, cation exchange. Cation exchange capacity, exchanging powers of cations, and adsorption by soil colloids. Fixation of cations and base saturation, anion exchange, adsorption by soil colloids, phosphate fixation and retention. Soil reaction and buffering capacity of soils.

Practical

Determination of pH, EC, C.E.C, sesquioxides (R_2O_3/$A1_2O_3$ ratio of soils) determination of Na^+, K^+, Ca^{++} and Mg^{++} contents of soil. Determination of CO_3^{2-}, HCO_3^-, SO_4^{2-} and $C1^-$ contents of soil.

ACS - 505 Soil Biology and Biochemistry (2+1)

Theory

Soil as biological habitat, soil organisms - their role in organic matter decomposition and nutrient transformations, soil organic matter- its nature and constitution; biology of root soil interface - microbial population in rhizosphere, its role in transport of nutrient; enzymes in soils their role in organic matter breakdown and plant nutrient transformations. Energy flow in plant microorganisms system. Biology of transformation of sulphur, zinc, iron and manganese. Soil organisms and pedogenesis, mycrorrhizae and plant nutrient. Biological equilibrium in soil biology of waterlogged and salt- affected soils, soil sickness due to biological agents; toxins and antibiotic production in soil. Biofertilizers in INMS.

Practical

Direct observation of micro organisms in soils, preparation and sterilization of microbiological media, isolation of bacteria, fungi, actinomycetes and algae from soil. Isolation of P solubilizing micro-organisms from soil.

ACS - 506 Analytical Techniques and Instrumental Methods in Soil and Plant Analysis (0+2)

Practical

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid- base, oxidation-reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling. Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils. Principles of visible, ultraviolet and infrared spectrophotometry, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X- ray by different methods. Electrochemical titration of clays; determination of cation and anion exchange capacities of soils, estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation

exachange capacity. Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods. 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 cations and anions and interpretation of results.

ACS - 507 Integrated Nutrient Management and Sustainable Agriculture (2+1)

Theory

The concept and objectives of integrated nutrient management (INM), soil degradation arising from continues soil mining and unbalanced nutrient management. Components of INM- soil nutrients, crop residues, green manure, organic manure , chemical fertilizers and biofertilizers ; INM and its effect on soil properties. Indian experience on INM. Concept of sustainable agriculture; frame work of sustainable agriculture. Soil resource management. Soil related constraints in crop production in different parts of India. National soils policy-need, recognition, objectives and implementation.

Practical

Determination of organic carbon, incubation studies of different types of organic matter in soil. Determination of N,P, K content of crop residues, green manures, organic manures etc.

ACS - 508 Radioisotopes in Soil and Plant Studies (2+1)

Theory

Atomic structures, radioactivity and units; radioisotopes -properties and decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter Principles and use of radiation monitoring instruments- proportional, Geiger Muller counter, solid and liquid scintillation counters; neutrons moisture meter, mass spectrometry, auto radiography, isotopic dilution techniques used in the 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. Doses of radiation exposure, radiation safety aspects, regulatory aspects, collection, storage and disposal of radioactive wastes.

Practical

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

ACS - 509 Soil, Water and Air Pollution (2+1)

Theory

Soil, water and air pollution problems associated with agriculture, nature and extent. Nature and sources of pollutants- agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants- their CPC standards and effect on plants, animals and human beings. Sewage and industrial effluents- their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal. Pesticides - their classification, behavior in soil and effect on soil microorganisms. Toxic elements- their sources, behavior in soil, effect on nutrients availability, effect on plant and human health. Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases- carbon dioxide, methane and nitrous oxide. Remediation

/amelioration of contaminated soil and water; remote sensing application in monitoring and management of soil and water pollution.

Practical

Sampling of sewage water, sewage sludge, solid/liquid industrial wastes, polluted soils and plants. Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological oxygen demand (BOD), nitrate and ammonical nitrogen and phosphorus, heavy metals 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 determination of particulate matter and oxides of sulphur. Visit to various industrial sites to study the impact of pollutants on soil and plants.

ACS - 510 Remote Sensing and GIS Techniques for Soil, Water and Crop Studies (2+1)

Theory

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interaction with matter. Sensor systems - camera, microwave radiometers and scanners; fundamentals of aerial photographs and image processing and interpretations. Application of remote sensing techniques- land use soil surveys, crops stress and yield forecasting, prioritization in watershed and draught management, wasteland identification and management. Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statistical techniques of evaluation of soil variability. Introduction to GIS and its application for spatial and non-spatial soil and land attributes.

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 database programme. Use of GIS for soil spatial simulations and analysis. To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning.

ACS - 511 Soil Erosion and Conservation (2+1)

Theory

History, distribution, identification and description of soil erosion problems in India. Forms of soil erosion; effect of soil erosion and factors affecting soil erosion; types and mechanism of water erosion; raindrops and soil erosion; rainfall erosivity-estimation as EI30 index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relations to soil properties and precipitation. Wind erosion-types, mechanism and factors affecting wind erosion; extent of problem in the country. Principles of erosion control; erosion control measures -agronomical and engineering; erosion control structures - their design and layout. Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet-lands. Watershed management-concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socio-economic aspects of watershed management; case studies in respect to monitoring and evaluations of watersheds; use of remote sensing in assessment and planning of watershed.

Practical

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

ACS - 512 System Approaches in Soil and Crop Studies (2+1)

Theory

System concepts- definitions, general characteristics; general systems theory; systems thinking, systems dynamics, systems behavior and system study. Model: definition and types; mathematical models and their types; modeling: concepts, objectives, processes, abstraction techniques; simulation models, their verification and validation, calibration; representation of continuous systems simulation models - procedural and declarative. Simulation - meaning and threats; simulation experiment, it's design and analysis. 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.

ACS - 513 Management of Problem Soils and Waters (2+1)

Theory

Area and distribution of problems soils- acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible. Morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils -soluble salts, ESP, pH; physical, chemical and microbiological properties.

Management of salt effected soils; salt tolerance of crops -mechanism and ratings; monitoring of soils salinity in the field; management principles for sandy, clayey, red, lateritic and dry land soils. Acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and it's management. Quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality. Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical

Characterization of acid, acid sulfate, salt-affected and calcareous soils. Determination of cations (Na^{+}, K^{+}, Ca^{++}, and Mg^{++}) in ground water and soil samples. Determinations of anions (Cl^{-},SO_4^{2-},$CO_3^{2-}$and HCO_3^{-}) in ground water and soil samples. Lime and gypsum requirements of acid and sodic soils.

ACS - 514 Fertilizer Technology (1+1)

Theory

Fertilizers - production, consumptions and future projections Manufacturing processes of nitrogenous (urea and ammonium sulphate), phosphatic (SSP and DAP) and potassic fertilizers (muriate of potash and potassium sulphate), rock phosphate- characteristics and use. Recent developments in secondary and micronutrient fertilizers. New and emerging issues in fertilizer technology- slow and controlled release fertilizers super granules fertilizers.

Practical

Quantitative analysis of NPK content in different fertilizers.

ACS - 515 Land Degradation and Restoration (2+0)

Theory

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, aforestation, organic products. 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.

PGS - 504 Basic Concepts in Laboratory Techniques (Compulsory Non-Credit Course) **(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; Neutralization of acid and bases; preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pump, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath, 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.