



TEERTHANKER MAHAVEER UNIVERSITY

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Delhi Road, Moradabad (U.P.)

SYLLABUS FOR RESEARCH APTITUDE TEST IN AGRICULTURE

The syllabus for Research Aptitude Test (RAT) in Agriculture is divided in two parts viz. Part A and Part B as described below:

PART – A

Part A of the RAT shall be designed to assess the research skills/aptitude of the candidate consisting of questions from the following areas:

- 1. Research Methodology:** meaning, characteristics, and ethical issues in research; types of research; research methods.
- 2. Logical Reasoning:** arguments, deductive and inductive research; logical and Venn diagram; inferences; analogies.
- 3. Data Interpretation:** interpretation of data; mapping and analysis of data, tools for data analysis; quantitative and qualitative research.
- 4. General Awareness about Basic Science:** basic science up to the level of SSC.
- 5. Mathematical Reasoning:** number series, letter series, codes; relationships, classification.

PART – B

Part-B of RAT is designed to assess the subject specific knowledge of the candidate covering the syllabus given as below:

1. AGRONOMY

Unit 1: Crop Ecology and Geography

Principles of crop ecology; Ecosystem-concept and determinants of crop productivity; Physiological limits of crop yield and variability in relation to ecological optima; Crop adaptation; Climate shift and its ecological implication; Greenhouse effect; Agro-ecological and agro climatic regions of India; Geographical distribution of cereals, legumes, oilseeds, vegetables, fodders and forages, commercial crops, condiments and spices, medicinal and aromatic plants; Adverse climatic factors and crop productivity; Photosynthesis, respiration, net assimilation, solar energy conversion efficiency and relative water content, light intensity, water and CO₂ in relation to photosynthetic rates and efficiency; Physiological stress in crops, detection and indices; Remote sensing: Spectral indices and their application in agriculture.

Unit 2: Weed Management

Scope and principles of weed management; Weed classification, biology, ecology and allelopathy; Weed seed dormancy, Crop weed competition, weed threshold; Herbicides in soils and plants; Application methods and equipment; Cultural, physical, chemical and biological weed control, bio-herbicides: Integrated weed management; Special weeds, parasitic and aquatic weeds and their management in cropped and non-cropped lands; weed

control schedules in field crops, vegetables and plantation crops; Role of Genetically Modified (GM) crops in weed management.

Unit 3: Soil Fertility and Fertilizer Use

History of soil fertility and fertilizer use; Concept of essentiality of plant nutrients, their critical concentrations in plants, nutrient interactions, diagnostic techniques with special emphasis on emerging deficiencies of secondary and micro-nutrients; Soil fertility and productivity and their availability and reaction in soils; Water solubility of phosphate fertilizers; Slow release fertilizers, nitrification inhibitors and their use for crop production; Principles and methods of fertilizer application including fertigation; Integrated nutrient management and bio-fertilizers; Agronomic and physiological efficiency and recovery of applied plant nutrients; Criteria for determining fertilizer schedules for cropping systems - direct, residual and cumulative effects; Fertilizer related environmental problems including ground water pollution; Site-specific nutrient management.

Unit 4: Dryland Agronomy

Concept of dryland farming; dryland farming Vs rainfed farming; History, development, significance and constraints of dryland agriculture in India; Climatic classification and delineation of dryland tracts; Characterization of agro-climatic environments of drylands; Rainfall analysis and length of growing season; Types of drought, effect on plant growth, drought resistance, drought avoidance, drought management; Crop Planning including contingency, crop diversification, varieties, cropping systems and mid-season corrections for aberrant weather conditions; Techniques of moisture conservation in-situ to reduce evapotranspiration, runoff and to increase infiltration; Rain water harvesting and recycling concept, techniques and practices; Summer ploughing, seed hardening, pre-monsoon sowing, weed and nutrient management; Concept and importance of watershed management in dryland areas.

Unit 5: Crop Production

sugarcane, tobacco, fodder and pasture crops including origin, history, distribution, adaptation, climate, soil, season, modern varieties, seed rate, fertilizer requirements, crop geometry, intercultural operations, water requirement, weed control, harvest, quality components, industrial use, economics and post-harvest technology. Package of practices in the respective locations.

Unit 6: Agricultural Statistics

Frequency distribution, standard error and deviation, correlation and regression analyses, coefficient of variation; Tests of significance t test, F test and chi-square (χ^2); Data transformation and missing plot techniques; Design of experiments and their basic principles, completely randomized, randomized block, split plot, strip-plot, factorial and simple confounding designs; Efficiency of designs; Methods of statistical analysis for cropping systems including intercropping; Pooled analysis.

Unit 7: Sustainable Land Use Systems

Tillage - Concept, types, tillage, tools and implements; Modern concepts of tillage and conservation agriculture; Land capability classification, Alternate land use and Agro forestry systems; Types, extent and causes of wasteland; Shifting cultivation; Concept of sustainability; Sustainability parameters and indicators; Agricultural and agro-industrial residues and its recycling.

Unit 8: Soil-Plant-Water Relationship

Importance of water in agriculture; Hydrological cycle; runoff and infiltration, factors affecting capacity, permanent wilting point, plant available water and extractable water; Soil irrigability water potential and its components; Movement of soil water-saturated and unsaturated water flow; Evapotranspiration (ET), PET, AET and its measurements. Crop coefficient; Plant water relations: Concept of plant water potential, its components; Methods of moisture estimation in plants. Soil and water conservation – measures – agronomical, mechanical and agrostological.

Unit 9: Irrigation Water Management

History of irrigation in India; Major irrigation projects in India; Water resource development; Crop water requirements; Concepts of irrigation scheduling, Different approaches of irrigation scheduling; Concept of critical stages of crop growth in relation to water supplies; Methods of irrigation viz. surface, subsurface and pressurized irrigation methods, merits and demerits; Measurement of irrigation water, application and distribution efficiencies. Conjunctive use of water; Interaction between irrigation and fertilizers.

Unit 10: Management of Problematic Soils and Crop Production

Response of crop to acidity, salinity, excess water and nutrient imbalances; Reclamation of problem soils, role of amendments and drainage; Crop production techniques in problem soils – crops, varieties, cropping system and agronomic practices; Degraded lands and their rehabilitation. Management strategies for flood prone areas; Drainage for improving water logged soils for crop production; Crop production and alternate use of problematic soils and poor quality water for agricultural.

Unit 11: Cropping and Farming Systems and Organic Farming

Cropping system – Definition, principles, classification; Cropping system for different ecosystem; Interaction and indices; Non-monetary inputs and low cost technologies. LEIA, HEIA and LEISA; Farming systems – type – natural, bio-dynamic, bio-intensive, response, precision, biological and organic farming; organic and bio inputs, Soil health and organic matter and Integrated organic farming systems; IFS – concepts, models for different ecosystem, resource recycling and evaluation.

2. PLANT PATHOLOGY

Unit 1: History and Principles of Plant Pathology

Milestones in phytopathology with particular reference to India. Major epidemics and their social impacts. Historical developments of chemicals, legislative, cultural and biological protection measures including classification of plant diseases. Physiologic specialization, Koch's postulates. Growth, reproduction, survival and dispersal of plant pathogens. Factors influencing infection, colonization and development of symptoms.

Unit 2: Laboratory and Analytical Techniques

Preparation and sterilization of common media. Methods of isolation of pathogens and their identification. Preservation of microorganisms in pure culture. Methods of inoculation. Measurement of plant disease. Detection and Diagnosis of pathogens in seeds and other planting materials: Nucleic acid probes, Southern, Northern and Western hybridization, ELISA, ISEM and PCR. Laboratory equipment and their use: autoclave, hot air oven, laminar flow, spectrophotometer, electrophoresis, light and MS, HPLC, Thermocycler.

Unit 3: Physiological and Molecular Plant Pathology

Altered metabolism of plants under biotic and abiotic stresses. Molecular mechanisms of pathogenesis: elicitors, recognition phenomenon, penetration, invasion, primary disease

determinant. Enzymes and toxins in relation to plant disease. Mechanisms of resistance, Structural and Biochemical defense mechanisms. R-Genes, Phytoanticipins. Phytoalexins. PR proteins, Hydroxyproline rich glycoproteins (HRGP). Antiviral proteins. SAR and ISR. HR and active oxygen radicals. Elementary genetic engineering. Management of pathogens through satellite, antisense - RNA. Ribozymes, coat protein, RNA interference, plantibodies, hypovirulence, cross protection. Useful genes and promoters, plant transformation techniques, biosafety and bioethics.

Unit 4: Mycology

Classification of fungi (According to the Classification – Kirk et al., 2008). Life cycles of important phytopathogenic fungi. Economic mycology, edible fungi and entomogenous fungi. Mycorrhizal associations. Cell organelles, their morphology, functions and chemical composition.

Unit 5: Plant Bacteriology

Identification and classification of bacteria. morphology, ultrastructure and chemical composition of prokaryotic cell in relation to function. Growth curve, nutrition and auxotrophic mutants. Resting cells in elementary bacterial genetics and variability: transformation, conjugation, transduction. Biology of extra chromosomal elements: plasmid borne genes and their expression. Bacteriophages: lytic and lysogenic cycles. Prokaryotic inhibitors and their mode of action. Economic uses of prokaryotes. Morphology, biochemical characteristics, reproduction and life cycle of phytoplasma and other fastidious prokaryotes.

Unit 6: Plant Virology

Nature, composition and architecture of viruses and viroids. Properties of viruses. Nomenclature and classification of viruses. Variability in viruses. Satellite viruses and satellite RNA. Mycoviruses and baculoviruses. Assay of plant viruses including biological, physical, chemical, serological and molecular methods. Conventional and biotechnological techniques used in detection and diagnosis. Behaviour of viruses in plants including infection, replication and movement. Histopathological changes induced by viruses in plants, inclusion bodies. Transmission of viruses: virus - vector relationships.

Unit 7: Plant Disease Epidemiology

Concepts in epidemiology. Development of disease in plant population. Monocyclic and polycyclic pathogens. Role of environment and meteorological factors in the development of plant disease epidemics. Survey, surveillance (including through remote sensing), and prediction and forecasting of diseases. Epidemic analysis and prediction models. Crop loss assessment: critical and multiple point models. Decision support system, cloud computing, GPS, GIS and GS in plant disease epidemiology.

Unit 8: Phanerogamic Parasites and Non-parasitic Diseases

Diseases caused by Phanerogamic parasites and their management. Diseases due to unfavourable soil environment, drought and flooding stress etc. Nutritional deficiencies. Primary /secondary air pollutants and acid rain.

Unit 9: Fungal Diseases of Crop Plants

Fungal diseases of cereals, millets, oilseeds, pulses, fruits, vegetables, plantation, fiber, spices, medicinal and ornamental crops with special reference to etiology, disease cycle, perpetuation, epidemiology and management. Postharvest diseases in transit and storage; aflatoxins and other mycotoxins and their integrated management.

Unit 10: Bacterial and Viral Diseases of Crop Plant

Crop diseases of cereals, pulses, oilseeds, sugar crops, vegetables, fruits, plantation and fiber crops caused by bacteria, viruses, viroids, phytoplasmas and other fastidious prokaryotes. Mode of transmission and pathogen vector relationships. Epidemiology and management.

Unit 11: Management of Plant diseases

General principles of plant quarantine. Exotic pathogens and pathogens introduced into India. Sanitary and phytosanitary issues under WTO, TRIPS and PRA. Genetic basis of disease resistance and pathogenicity: gene for gene hypothesis; breeding for disease resistance. Production of disease free seeds and planting materials. Seed certification. Chemical nature and classification of fungicides and antibiotics: their bioassay and compatibility with other agricultural chemicals; resistance to fungicides/ antibiotics; effect on environment. Spraying and dusting equipments, their care and maintenances. Important cultural practices and their role in disease management, solarization, integrated disease management. Microorganisms antagonistic to plant pathogens in soil, rhizosphere and phyllosphere and their use in the control of plant diseases; soil fungistasis. Plant growth promoting Rhizobacteria. Biotechnology for crop disease management.

3. SOIL SCIENCE

Unit 1: Pedology

Concept of land, soil and soil science. Composition of earth crust and its relationship with soils; Rocks, minerals and other soil forming materials; Weathering of rocks and minerals; Factors of soil formation; Pedogenic processes and their relationships with soil properties; Soil development; Pedon, polypedon, soil profile, horizons and their nomenclature. Soil Taxonomy - epipedons, diagnostic subsurface horizons and other diagnostic characteristics, soil moisture and temperature regimes, Interpretation of soil survey data for land capability and crop suitability classifications, Fertility Capability Classification- Nutrient indexing. Macro-morphological study of soils. Application and use of global positioning system for soil survey. Soil survey- types and techniques. Soil series characterization and procedure for establishing soil series, benchmark soils and soil correlations. Study of base maps: cadastral maps, toposheets, aerial photographs and satellite imageries. Use of geographical information system for preparing thematic maps. Application of Remote Sensing in soil survey and mapping. Soils of India.

Unit 2: Soil Physics

Significance of soil physical properties. Soil texture – Stoke's Law- textural classes. Soil structure – classification, soil aggregation and significance, soil consistency, bulk density and particle density of soils and porosity, their significance and manipulation. Soil water-retention and potentials. Soil moisture constants. Movement of soil water- saturated and unsaturated flow- Darcy's law - hydraulic conductivity - infiltration, percolation, permeability, drainage and methods of determination of soil moisture. Thermal properties of soils, soil temperature. Soil aircomposition, gaseous exchange, influence of soil temperature and air on plant growth. Soil physical constraints affecting crop production and their management strategies. Methods of soil analysis - particle size distribution, bulk and particle density, moisture constants. Soil erosion - types, effects, Rain erosivity and soil erodibility. Runoff - methods of measurement, factors and management. Soil conservation measures. Characterization and evaluation of soil and land quality indicators; Causes of land degradation; Management of soil physical properties for prevention/restoration of land degradation; management of waste lands; Concept of watershed – its characterization and management.

Unit 3: Soil Chemistry

Chemical composition of soil; Soil colloids - structure, composition, constitution of clay minerals, amorphous clays and other non-crystalline silicate minerals, oxide and hydroxide minerals; Charge development on clays and organic matter; pH-charge relations; Buffer capacity of soils. Inorganic and organic colloids- surface charge characteristics, diffuse double layer, zeta potential. Soil organic matter fractionation, humus formation and theories clay-organic interactions. Cation exchange — Hysteresis-definition. Nitrogen, potassium, phosphorus and ammonium fixation in soils and management aspects.

Unit 4: Soil Fertility

Essential elements in plant nutrition; Nutrient cycles in soil; Transformation and movement of nutrients (Macro and micro nutrients) in soil; Manures and fertilizers; Fate and reactions of fertilizers in soils; Slow release fertilizers and nitrification retarders- Soil fertility evaluation Concepts and approaches ;. FCO Soil fertility evaluation – soil testing, plant and tissue tests and biological methods; Common soil test methods for fertilizer recommendation; Nutrient Management concepts- INM, IPNS, SSNM- Soil test-crop response correlations; Fertilizer application methods- Nutrient use efficiency- Macro and micronutrients. Nature, properties and development of acid, acid sulphate, saline and alkali soils and their management; Lime and gypsum requirements of soils; Irrigation water quality - EC, SAR, RSC. Fertility status of soils of India. Pollution: types, causes, and management. Carbon sequestration and carbon trading. Modern methods of soil, plant and fertilizer analysis; Flame photometry and inductively coupled plasma optical emission spectroscopy; Spectrophotometry - visible, ultra-violet and infrared; Atomic absorption spectrophotometry; Potentiometry and conductimetry; X-ray diffractometry; Mass spectrometry.

Unit 5: Soil Microbiology

Soil biota, soil microbial ecology, types of organisms. Soil microbial biomass, microbial interactions, unculturable soil biota. Microbiology and biochemistry of root-soil interface. Phyllosphere. Soil enzymes, origin, activities and importance. Soil characteristics influencing growth and activity of microflora. Microbial transformations of N, P, K, S, Fe and Zn in soil. Biochemical composition and biodegradation of soil organic matter and crop residues. Humus formation. Cycles of important organic nutrients. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures. Biofertilizers – definition, classification, specifications, method of production and role in crop production.

Unit 6: Statistics

Experimental designs for pot culture and field experiments; Statistical measures of central tendency and dispersion; Correlation and regression; Tests of significance - t and F tests; Computer use in soil research, Geostatistics.