

## **Ph.D. Entrance Syllabus of Agriculture-Crop Physiology**

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### **PART--I**

#### **Research Methodology (50 Questions)**

**Research Aptitude:** Research concept, steps involved, identification, selection and formulation of research problem, justification, hypothesis; literature collection---textual and digital resources (internet).

Advances in Microscopic Techniques- LM, EM, Confocal Microscopy, Karyotyping, Image analysis softwares.-Use of HPLC, amino acid analyzer and Bomb Calorimeter. Centrifuge, paper chromatography, spectrophotometer. Basic concepts of extraction and quantification of nucleic acid and proteins. Protein and nucleic acid electrophoresis, Northern and southern blots, FISH and GISH. Protein and DNA band profiling through gel documentation system, PCR, cloning, sequencing, microarray.

**Research design, data collection and interpretation:** Research design; sampling techniques, collection and documentation, presentation, analysis and interpretation of data

**Scientific writing:** Forms of scientific writing--- Article, notes, reports, review article, monographs, dissertations, popular science articles, bibliographies,

**Formulation of scientific communication:** Outline preparation, drafting title, sub titles, tables, illustrations; Formatting tables---title, body footnotes; figures & graphs---structure, title and legends, Impact factor, citation indices, plagiarism

**Computer application:** MS office, excel, power point, graphics (Sigma plot), statistical software (SPSS)

**Biostatistics:** Statistical Methods: Measures of central tendency and dispersal; probability, distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non---parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t---test; Analysis of variance;  $\chi^2$  test; Basic introduction to Multivariate statistics, etc.

## **Part-II**

### **Crop physiology/Plant Physiology (Subject specific 50 questions)**

#### **Cell Organelles and Water Relations**

Cell organelles and their physiological functions Structure and physiological functions of cell wall, cell inclusions. Cell membrane structure and functions. Water and its role in plants, properties and functions of water in the cell, water relations, water potential of plant cells. Mechanism of water uptake by roots transport in roots, movement of water in plants, water loss from plants, energy balance, solar energy, input energy dissipation at crop canopy level. Evapotranspiration, plant factors influencing transpiration rate. Stomata, structure function - Mechanism of stomatal movement, antitranspirants. Physiology of water high temperature and salinity stress in plants. Influence of water stresses at cell, organ, plant and canopy levels. Indices for assessment of drought resistance.

#### **Metabolic Processes and Growth Regulation**

Energy and work, free energy and chemical potential, redox reactions and electrochemical potential. Enzyme classification and mechanism of action, factors affecting enzyme action. Gene expression and protein turnover. Photosynthesis, translocation and respiration as key processes regulating carbon metabolism and plant growth. Photosynthesis and bioproductivity. Photochemical process-Chloroplast, its structure, CAM plants and their significance. Rubisco structure and regulations, Photorespiration and its significance, CO<sub>2</sub> fixation as a diffusive process, effect of environmental factors on photosynthetic rates. Synthesis of sucrose, starch, oligo and polysaccharides. Translocations of photosynthates and its importance in sink growth. Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration and its significance. Nitrogen metabolism. Inorganic nitrogen species (N<sub>2</sub>, NO<sub>3</sub>, NH<sub>3</sub>) and their reduction, protein synthesis, nucleic acids. Sulphate uptake and reduction. Lipid metabolism- storage, protective and structural lipids. Secondary metabolites and their significance in plant defence mechanism. Growth and differentiation, hormonal concept of

growth and differentiation, plant growth hormones (auxins, gibberellins, cytokinins, ABA, ethylene, etc.), biosynthesis of growth hormones and their metabolism, synthetic growth regulators, growth retardant, apical dominance, senescence, fruit growth, abscission, photo-morphogenesis, photo-receptors, phytochrome, physiology of flowering, photoperiodism and vernalisation.

### **Crop Productivity and Modeling**

Role of crop physiology in agriculture, crop growth and productivity, crop growth models

describing yield (Duncan/Passioura), phenology-crop productivity, growth factors related to biomass - concept of growth rates canopy photosynthesis (leaf area and net assimilation rates as determining factors). Light interception as a major function of leaf area-index, LAD canopy architecture- Light extinction coefficient relative growth rate. Net assimilation rate. Biomass and yield relations. Assimilate partitioning, yield and yield structure analysis. Concept of source and sink, factors influencing source and sink size and productivity. Environmental factors determining

### **Abiotic Stress Responses in Plants**

Abiotic stresses affecting plant productivity. Basic principles of a crop improvement programme under stress, interactions between biotic and abiotic stresses. Drought 21 characteristic features, water potential in the soil-plant-air continuum. Development of water deficits, energy balance concept, transpiration and its regulation – stomatal functions/VPD. Physiological process affected by drought. Drought resistance mechanisms: Escape, dehydration postponement (Drought avoidance), Dehydration tolerance, and characteristics of resurrection plants. Osmotic adjustment Osmoprotectants, stress proteins. Water use efficiency as a drought resistance trait. Molecular responses to water deficit stress perception, expression of regulatory and function genes and significance of gene products. Stress and hormones-ABA as a signaling molecule – Cytokinin as negative signal. Oxidative stress: reactive oxygen species (ROS) – role of scavenging systems (SOD, catalase etc.). High temperature stress: tolerance mechanisms- role of membrane lipids in high temperature tolerance. Functions of HSPs chilling stress; effects on physiological processes. Crucial role of membrane lipids. Salinity: species variation in salt tolerance. Salinity effects at cellular and whole plant level, tolerance mechanisms. Breeding for

salt resistance. Heavy metal stress: aluminum and cadmium toxicity in acid soils. Role of phytochelatins (heavy, metal binding proteins).

## **Plant Growth Regulators and Plant Development**

Plant growth regulators – Hormones, endogenous growth substances and synthetic chemicals. Endogenous growth regulating substances other than hormones. Brassinosteroids, triacontanol, phenols polyamines, jasmonates, concept of death hormone. Classification, site of synthesis, biosynthetic pathways and metabolism and influence on plant growth and development by auxins, gibberellins, cytokinins, abscisic acid and ethylene. Concept of hormone action - hormone receptors and signal transduction Hormone mutants. Hormonal regulation of gene expressions at various developmental stages of plant-flowering, seed maturity, seed dormancy. Action of hormones on cellular functions: Auxins- cell elongation, retardation of abscission of plant parts, gibberellins – stem elongation, germination of dormant seeds, cytokinins-cell division, retardation of senescence. Absciscic acid stomatal closure and induction of drought resistance, ethylene- fruit ripening, acceleration of senescence of leaves. Interaction of hormones in regulation of plant growth and development processes. Synthetic growth regulators, growth retardants, apical dominance, senescence, fruit growth, abscission. Growth and differentiation,

hormonal concept of growth and differentiations. Rooting of cuttings- flowering- physiological and molecular aspects of control of reproductive growth. Apical dominance, senescence and abscission. Fruit growth and development, physiological and molecular aspects of ripening processes and improving post-harvest life of fruits. Induction and breaking dormancy in seeds and buds. Synthetic growth regulators. Practical utility in agriculture and horticulture. Herbicides, classification and their mode of action.

## **Mineral Nutrition**

Importance of mineral nutrition in plant growth. Classification and essentiality criteria. General mechanisms - concept of apparent free space and nature of bio-membranes. Dual mechanism and other concepts of ion uptake. Short distance transport-pathway from external solution (Apoplast) to sieve across the root cortical cells-factors contributing to xylem loading. Long distance transport in xylem and phloem, xylem unloading in leaf cells. Uptake and release of mineral

nutrients by foliage. Rhizosphere and root biology, root growth, influence of microorganism in nutrient acquisition, release and uptake by plant roots. Yield and mineral nutrition-concept of nutrient use efficiency, Mineral nutrition under adverse soil situations- drought, salinity, acidity etc. Heavy metal toxicity and concept of phytoremediation. Interaction of phytohormones and nutrients. Molecular aspects- uptake and transport, role of transporter genes, genetics of nutrient uptake, identification and transfer of genes for tolerance to nutrient deficiencies, etc. Soil less culture – Hydroponics - Role of Macro, Micro and beneficial nutrients- Identification of nutrient deficiencies and toxicities.

### **Morphogenesis, Tissue Culture and Plant Transformation**

Morphogenesis; the cellular basis of growth and morphogenesis; polarity in tip growing cells and diffusive growing cells. Control of cell division and differentiation, phyto-chromes, different forms, physiological effects and gene regulation, and cellular totipotency, physiology and biochemistry of differentiation, in organ cell, tissue and cultures, micropropagation strategies, application of tissue culture in agriculture, horticulture, forestry and industry: plant transformation; transformation vectors, concept of selectable and scorable markers. Agrobacterium mediated transformation, binary vectors, biolistics. Electroporation, selection of putative transgenic plants, genetic analysis. PCR, Southern analysis evaluation of transgenic plants.