DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE-13): Plant Stress Biology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Stress Biology DSE-13	**4**	**2**	**0**	**2**	Semester VII	Nil

Learning Objectives:

This course explores the physiological, biochemical, and molecular mechanisms by which plants respond to environmental stresses. It covers abiotic and biotic stress factors, their impact on plant growth and development, and adaptive mechanisms to mitigate stress effects. The course also introduces strategies for improving stress tolerance in crops. The following are the specific objectives of this course:

- Identify key abiotic and biotic stress factors affecting plants and explain the associated physiological, biochemical, and molecular responses.
- Examine plant signaling pathways and adaptive strategies such as avoidance, acclimation, and resistance under stress conditions.
- Gain hands-on experience in plant identification, vegetation assessment, and classification techniques, with emphasis on ecological and agricultural relevance.
- Apply principles from plant physiology, molecular biology, and biochemistry to analyze plant-environment interactions and stress resilience.
- Critically assess transgenic and biotechnological approaches to enhance plant tolerance to climate stress and improve crop productivity.

Learning Outcomes:

At the end of this course students will be able to:

- Identify different types of plant stresses and their effects on plant physiology.
- Understand the molecular and biochemical responses of plants to stress.
- Analyze plant adaptation and tolerance mechanisms under stress conditions.
- Explore strategies to enhance plant resilience against environmental challenges.
- Apply knowledge of plant stress biology in agricultural and environmental contexts.

Theory : **30 hours**

Unit 1: Introduction to Plant Stress Biology, Abiotic and Biotic Stresses **15 hours**

Types (abiotic and biotic), Perception, Acclimation vs Adaptation, Phenotypic plasticity.

- Drought stress- Physiological and Biochemical responses, Resistance or Tolerance mechanisms
- Salinity- Osmotic and Cytotoxic effects, Ion homeostasis, Salt-tolerant mechanisms: Developmental and Physiological protective mechanisms-exclusion vs tolerance, Osmoprotectants, Ion transporters, Compatible solutes- glycine betaine, proline
- Temperature - Cold and heat stress (in brief)
- Stress caused by Pathogens, Herbivores, Parasitic plants, Susceptibility and Resistance, PR proteins, Pattern-triggered immunity and Effector triggered immunity (in brief).

Unit 2: Stress Sensing and Signaling Mechanisms **7 hours**

Hormonal regulation (Abscisic acid, Jasmonic acid, Salicylic acid), Reactive Oxygen Species and Nitrous Oxide, Salt Overly Sensitive pathway, Late embryogenesis abundant proteins (LEA), Calcium signaling and binding proteins.

Unit 3: Stress Tolerance Mechanisms **6 hours**

Antioxidant enzymes (Superoxide dismutase, Catalase, Peroxidase), Osmolytes, Secondary metabolites (Alkaloids, Phenolics and Terpenoids), Chaperones (Heat Shock Proteins).

Unit 4: Crop Improvement Strategies **2 hours**

Traditional plant breeding (Mutation breeding, Protected cultivation) and Biotechnological approaches (brief account of stress tolerant genetically engineered plants).

PRACTICALS: **60 hours**

1. To study the effect of salt stress on seed germination percentage.
2. To study the effect of salt stress on plant shoot and root length.
3. To study the effect of stress (any one) on chlorophyll content.
4. To determine electrolyte leakage in stressed plants.
5. To determine SOD or peroxidase enzyme activity in control and stress plants.

Experiments through demonstration (through photographs)

6. To study the plant responses under environmental stress (Stomatal closure, Leaf curling, Root alteration, Stunted plant growth, Wilting).
7. To demonstrate the effect of stress on total protein through 2-D gel electrophoresis profile.
8. To study the effect of stress on plant cell wall and membrane.

9. To study the effect of biotic stress on plants through photographs (necrosis, rotting, nematode attack, SAR).

Suggested Readings:

1. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018). Plant Physiology and Development, 6th edition. New York, NY: Oxford University Press, Sinauer Associates.
2. Bhatla, S.C., Lal, M.A. (2018). Plant Physiology, Development and Metabolism. Singapore: Springer Nature, Singapore Pvt. Ltd.
3. Giri, B., & Sharma, M. P. (Eds.) (2021). Plant Stress Biology: Strategies and Trends. Springer Nature.
4. Buchanan, B. B., Gruissem, W., & Jones, R. L. (Eds.) (2015). Biochemistry and molecular biology of plants. John wiley & sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.