

PLANT PHYSIOLOGY Lecture 19 - Mineral Nutrition

- I. Review of water potential
 - A. Water potential (ψ) = pressure potential (ψ_p) + osmotic potential (ψ_s)
 - 1. Water potential - a measure used to predict the direction of water flow (from high to low)
 - a) Pressure potential - turgor pressure (associated with cell growth & expansion)
 - b) Osmotic potential - can be used to regulate turgor - regulates plant water movement
- II. Water and mineral absorption by roots
 - A. Absorption of water by roots
 - 1. Driven by transpiration - negative pressure in xylem draws water in through free space - water must move through living cells of endodermis
 - 2. Root pressure (driving force when transpiration is low - high humidity)
 - a) Solutes (sugars) built up in roots cause an osmotic drive of water from surrounding media solution to inner root (i.e., water moves from higher potential to lower potential)
 - b) Xylem transport driven by positive pressure - source for guttation
- III. Uptake of mineral nutrients: two theories (mass flow and active transport)
 - A. Mass Flow - probably PASSIVE
 - 1. Movement of ions by "sweeping" effect - major source of nutrients
 - 1. Minerals may flow with water into root by "facilitated" diffusion
 - B. Active uptake of minerals
 - 1. Energy-requiring transport of ions into cells of the cortex (mostly minerals in relatively low abundance in soil solution - potassium, nitrate, etc.)
 - 2. Movement into xylem is blocked by special barrier (casparian strip of an endodermis) - promotes active transport
 - a) Endodermis (with casparian strip) requires that molecules pass through a plasma membrane to enter (or leave) the vascular cylinder
- IV. Availability of nutrients
 - A. Soil - a net negative charge
 - B. Soil environment - pH, texture, organic matter, moisture, etc.
- V. Xylem transport
 - A. Mechanism of xylem transport (cohesion-adhesion-tension hypothesis)
 - 1. Tracheids and vessels usually dead, empty cells
 - 2. Transport by bulk flow - driven by transpiration
 - a) Transpiration causes "suction" and negative pressure on water in xylem
 - 3. Important characteristics of water
 - a) Cohesion - attraction of water molecules to each other
 - b) Adhesion - attraction of water to other molecules (like cell walls)
 - c) Tension - ability of water to withstand negative pressure
- VI. Mineral nutrition
 - A. CHOPKNS CaFe Mg B Mn CuZn Cl Mo
 - 1. CHO - carbohydrates
 - 2. P - ATP K - enzymes & stomates N - proteins
S - amino acids Ca - membranes Fe - ETS & photosynthesis
Mg - chloro. B - CHO breakdown Mn, Cu, Zn - enzymes
Cl - OEC Mo - enzymes