Slide 1

Physical Factors Affecting Plants

Lecture 15

Slide 2

Learning Outcomes

- Soil constraints
  - Available water
  - acidity
- Wind exposure
- Too much sun
- Too much water
- Soil Salinity

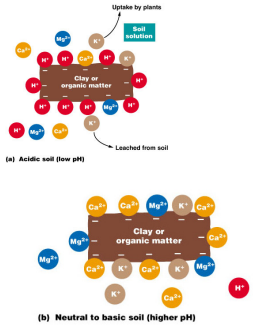
Slide 3

Factors Affecting Plant Growth

- In order to grow plants need…..
- Adequate light
- Adequate water
- Adequate Nutrients
- Space
- These are limited in supply…..and there are other interested parties

Slide 4

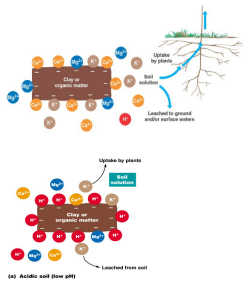
Cation Exchange Capacity



- Cation = positive charge
  - Calcium Ca^{2+}
- Anion = negative charge
  - Nitrate NO_3^-
- Organic matter and clay negatively charged
- Cation exchange capacity-
  - the ability of a soil particle to hold onto cations

Slide 5

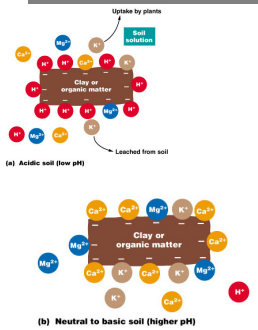
CEC and Soil Fertility



- Cations retained by the negatively charged particles in the soil
  - Clays and humus
- In equilibrium with similar cations in the soil solution
- Also taken up by plants
- If not retained lost by leaching
- Sandy soils low CEC = low fertility
- Acidic Soils exchange sites occupied by H^+ = low fertility

Slide 6

CEC and Soil Acidity

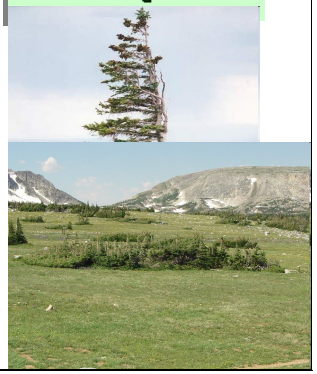


- Clay and humus particles determine CEC
- High CEC = ability to retain cations - many of which are nutrients
  - Sodium Na^+
  - Potassium K^+
  - Calcium Ca^{2+}
  - Magnesium Mg^{2+}
- Unattached ions are subject to leaching
- Acidity lowers soil CEC
  - H^+ ions displace cations into the soil solution
  - Al^{3+} ions become soluble

Slide 7

Wind Exposure

- Wind
- Increased rate of evaporation
  - Water loss from soil
- Increased rate of transpiration
  - Water loss from leaves
- Flagging
- Prevailing direction of wind chills and kills buds
- Tree islands
- Krummholz



Slide 8

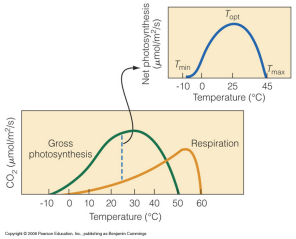
Coping with Heat

- Leaves absorb light but also absorb heat
- Reduced leaf area
- Chaparral shrubs
- cacti
- Leaf orientation

- Heat radiated from leaf to air
- Increasing surface area of leaf increases rate of cooling
- Compound leaves

Leaf Temperature

- As leaf temperature rises from 0°C rates of photosynthesis and respiration rise
- Maximum rate determined by Rubisco enzyme response to temperature
- Above max temp photosynthesis rate declines



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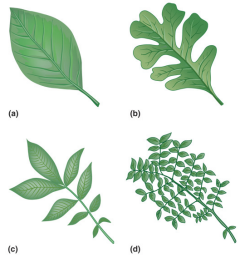
Leaf Shape

- Leaves absorb both light and heat radiation
- Only 5% of energy used for photosynthesis
- Overheating damages leaves
- Heat lost by:
- Transpiration
- Convection
- Boundary layer
- Small leaves, compound leaves reduce boundary layer and speed up convective heat loss



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Slide 11

Limiting Factors

- If water is limiting – deserts
- To survive plants invest in more roots and decrease production of leaves
- If light is limiting
- Plants grow more shoots to increase rate of photosynthesis
- What if nutrients are limiting?

Slide 12

Root:Shoot Ratio

- Roots provide water and nutrients
- Do not photosynthesize
- Shoots (stems and leaves) photosynthesize
- Require water and nutrients
- Range from 0.2 in rainforests to 1.2 in arid shrublands (SE. California) to 4.5 in deserts

Slide 13

Lack of Water

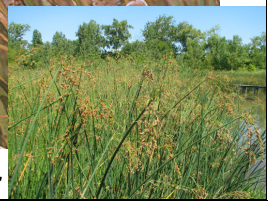
- In arid environments plant compete for soil water
- Deeper roots access ground water
- Shallow spreading roots soak up rains

Quercus douglasii – Blue Oak

Slide 14

Too Much Water

- Root cells need oxygen to live
- In waterlogged soil air replaced by water
- Bacteria use up oxygen
- anaerobic bacteria produce toxic forms of nitrogen and manganese



Scirpus californicus

Slide 15

Adaptations to Waterlogged Soils

- Waterlogging tolerant plants develop aerenchyma
- *Scirpus californicus* – California Tule

Slide 16

Too Much Salt

- Saltmarshes
- Desert Soils

Spartina foliosa

Adaptations to Salinity

- Halophytes
- Poaceae
- Chenopodiaceae
- Salt excreting glands