Diseases caused by Environmental Factors in the Landscape

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Introduction

- Plants grow best within certain ranges of various environmental factors
  - temperature
  - soil moisture, nutrients, pH, and structure
  - light
  - humidity
- These factors have a great impact on cultivated plants
  - may be grown in an environment out of normal range or completely artificial

General characteristics

- "Abiotic diseases" are caused by environmental factors:
  - a lack of or too much of something that supports life
  - non-infectious (cannot be transmitted)
  - may occur at any point of plant production or maintenance
  - symptoms may be slight to very severe

Diagnosis of abiotic diseases:

- Based on
  - symptoms
  - careful examination of plant environment:
    - weather
    - recent changes in atmosphere or soil
    - cultural practices
- Can be very complex if symptoms
  - are indistinct
  - closely resemble other disease agents

Control

- Mitigate the environmental stress factor
  - sometimes easier said than done!

Abiotic (noninfectious) agents

- Extremes in soil moisture, temperature, nutrients, and pH
- Dehydrating winds
- Chemicals (herbicides, salt, and toxic metals)
- Air pollution (ozone, sulfur dioxide, fluoride, and ethylene)
- Poor planting
- Physical damage

Today

- Temperature stress
- Drought
- Chemical injury (ozone, herbicides, de-icing salt)
- Mechanical injury
- Poor site conditions

Temperature

- Plants grow best from 1 to 40 C (optimum at 15 to 30 C)
  - vary with plant species, stage of growth, and plant part
- Storage organs may survive lower temperatures

High temperature stress

- Doesn't often occur in nature – more likely in an artificial environment
- Occurs in conjunction with other environmental factors:
  - excessive light
  - drought
  - lack of oxygen
  - high winds
- High temperatures affect action of enzymes and can denature proteins

Sunscald

- Susceptible tissues exposed to the sun "burn"
- Tissues brown, blister, and desiccate

Tree was exposed to overhead irrigation on a hot day

Note marginal leaf scorch

Low temperature stress

- Severity varies with plant part affected and time of year
- Low temperatures induce ice formation within or between plant cells

Cold acclimation

- In most woody plants of the temperate zone, plants acclimate by:
  - extracting water from cells into intercellular spaces, where it freezes
  - "supercooling" remaining intracellular water
- Acclimation protects plants to minimum temperatures of -4 and -40 F
- Deacclimated tissues are harmed by below-freezing temperatures

Freezing during dormancy

- Freezing injury occurs when deacclimation is delayed in fall or following a period of unseasonably warm winter temperatures

Frost damage

- Frost damage occurs when tissues deacclimate normally and are then subject to unseasonably cold temperatures
- More severe in drought-stressed trees

Moisture extremes

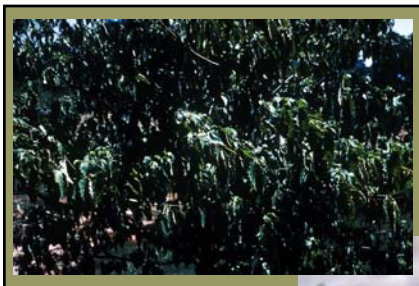
- Probably the most damaging of all environmental factors
- May affect small or very large areas
- Moisture problems include:
  - drought stress (today)
  - combined moisture and temperature stresses
    - summer drying
    - winter burn (or winter desiccation)
  - excessive moisture

Low soil moisture: drought

- Occurs when water loss from the leaves exceeds water uptake in the roots
- Temporary drought stress occurs daily
- Native plants:
  - adapted to variations in water supply
  - injured only by very severe drought
- Planted trees and shrubs often show symptoms of severe water stress
- Drought stress results in damage to plants and predisposes plants to other diseases as well as injury from insects

Immediate symptoms of drought

- Stomates close, and photosynthesis and growth may slow or cease
- Leaves droop, wilt, curl, turn yellow, scorch at margins, or drop prematurely (older leaves go first)
- Needles on conifers lose turgor, droop near the base, fade, and remain permanently bent
- Green tissues and fruit shrink
- Stress usually appears on trees in groups because of common conditions; smallest trees sustain the greatest injury



Wilting of foliage due to water stress

http://www.oznet.ksu.edu/hfrr/extensn/POW/August_22.htm

Marginal, uniform leaf scorch associated with drought stress

Edge burn associated with abiotic stress on conifers

Longer term impact of drought

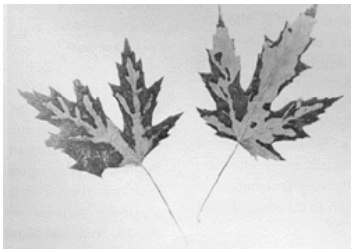
- Reduced root and shoot growth (damaged roots, shortened needles, sparse foliage)
- Thinning and death of upper tree canopy
- Cracks in the sapwood
- General decline in vigor
- Hard and compacted soil
- Weakened trees are more susceptible to other diseases, stresses, and insects

Long-term drought stress

In nature, drought stress, heat stress, and freezing are all tied in together

Related problems: summer drying

- Intense, short-term water stress occurs in young leaves exposed to drying during bright, hot, windy weather
- Leaf scorch occurs



Related problems: winter dessication

- In dormant plants, water evaporates from leaves during warm weather in winter and is not replaced, causing winter burn or scorch

Winter desiccation

Plants vulnerable to drought:

- Shallow-rooted trees (drying most rapid in uppermost layer of soil)
- Seedlings (underdeveloped root systems; lack internal reservoir of water)
- Newly transplanted trees (loss of absorbing roots)
- Plants in highly porous rooting medium (dries out)

What happens when water returns to soil?

- Recovery is very slow
- Absorption of water by roots begins, but it takes several days to reach normal capacity
- Shrunken organs expand quickly
- Stomates may open only slowly; rate of photosynthesis remains at pre-stress level for a long time
- Behavior varies with species and severity of stress

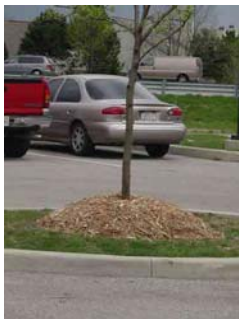
Surviving drought

- Irrigate as needed (especially newly planted and shallow-rooted trees)
- Control weeds and grasses to reduce competition
- Remove dead trees/branches as soon as possible to prevent hazards

Surviving drought (cont.)

- Add organic matter to dry or gravelly soils at planting
- Use up to 3 inches of mulch
- Avoid “beehive” or “volcano” mulching

"Volcano" mulching



http://www.hort.purdue.edu/ext/WRG_volcano.html

http://www.tlcfortrees.info/mulching_staking.htm

Pests common on drought-stressed plants

- Armillaria root rot
- Canker (e.g., Atropellis, Botryosphaeria, Cytospora, Hypoxylon, Nectria, Thyronectria cankers)
- Dogwood anthracnose
- Verticillium wilt
- Powdery mildew
- Pine wilt disease
- Borer (especially on birch, dogwood, and oak)

Chemical injury

- Pollutants
  - ozone
- Herbicides
- De-icing salt

Air pollution: ozone

- Ozone is formed in the air by the action of sunlight on hydrocarbons and oxides of nitrogen (i.e., other pollutants in exhaust from internal combustion engines)
  - photochemical reaction
  - secondary pollutant
- Ozone enters stomates (giving foliage a stippled appearance) and kills cells
- Because sunlight is needed:
  - levels are higher during the day and lower at night
- Warm conditions favor these reactions:
  - so ozone levels are higher in the summer

Ozone injury in poplar

Ozone injury in white pine

Ozone injury in tobacco (note flecking)

Herbicides

- Most are safe if used properly (correct crop, timing, dosage, and environmental conditions)
- Most injury is non-target and occurs when:
  - dose is excessive
  - temperatures are too hot or cold
  - applied at wrong time of year
  - spray droplets drift to sensitive plants
- Types of injury:
  - herbicide is translocated to growing points where it has a growth regulator effect
  - "burn patterns" that corresponds with droplet size

Atrazine in geranium

2,4-D in gingko

2-4,D in balsam fir

Misapplication of herbicides on right-of-way

De-icing salt

- Commonly used compounds:
  - NaCl (sodium chloride or rock salt)
  - CaCl2 (calcium chloride)
- Chloride anion (Cl^-) injures vegetation
- Sodium cation (Na^+) causes soil compaction

Salt injury

- Damages occur to plants when
  - roots take up water contaminated with chloride; chloride translocated to growing points
  - salt is sprayed on foliage and causes a contact burn
- Injury also occurs by
  - a single exposure to a high concentration of salt
  - graduate accumulation of ions to toxic levels in tissue

De-icing salt injury

Salt toxicity in turfgrass

De-icing salt injury

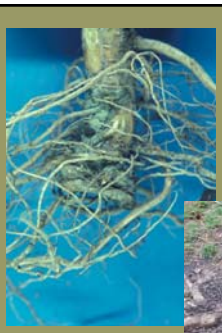
Degree of injury depends on:

- Kind of salt applied
- Timing of application
- Soil type and drainage
- Terrain
- Total precipitation
- Depth and duration of freezing soil
- Plant species

Mechanical damage

Lightning

Girdling root -- “telephone pole”



Girdling roots

String-tie at base of tree

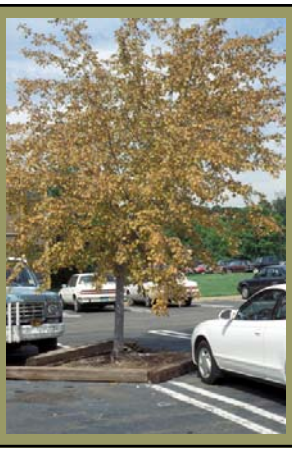
String-tie at base of tree

Tractor damage

Poor site conditions

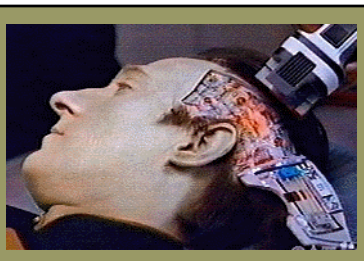
- Planting errors
  - incorrect planting depth
  - “transplant shock”
- Placement errors
- Poor maintenance

Planted too deep



What’s wrong with this tree?

What’s the problem here?



http://www.forestpathology.org/concepts.html

Microchip won’t hold any more weird plant pathology data, Captain!