Recognizing physiological responses of plants to heat and drought stress

Managed landscapes continue to experience excessively hot, dry summers in many parts of the world due to our changing climate. Many of the physiological responses plants have to these environmental stresses are reflected in morphological changes. Recognizing these changes not only helps gardeners identify the environmental stressors responsible, but also assists in determining immediate treatment and future prevention.

General plant stress symptoms

- Wilting
- Chlorosis
- Necrosis and dieback
- Epicormic shoots
- Unseasonal leaf reddening

Causes and symptoms of water stress

- Leaf water stress
    - Wilting, especially in young tissues
    - Tip and marginal reddening
    - Tip and marginal necrosis
    - Decrease in mature leaf size
    - Increase in premature senescence
- Salinity
    - Wilting
    - Marginal and tip necrosis
    - Premature leaf drop
    - White crusts of salt
- Hypoxia (Includes flooding, compaction and improper soil amendment)
    - Indirect water stress - leaf wilt, necrosis, and abscission
    - Leaf dieback or reduced leaf size
    - Adventitious roots
    - Root tip dieback

Using anthocyanins to diagnose water stress

- Young tissues
    - Relative lack of cuticle
    - Need for high turgor
- Deciduous tropical trees
- Temperate evergreens

Management-induced water stress

- Poor soil preparation
- Poor installation
- Poor soil management

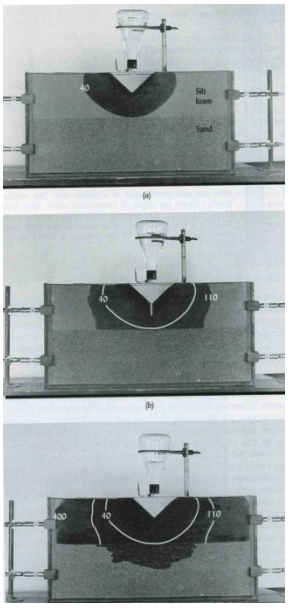
Poor soil preparation

Myth: Build a healthy soil by incorporating lots of organic matter

Facts: Improper amendment

- creates restrictive soil interfaces
- leads to subsidence and compaction
- causes nutrient overload

Restrictive soil interface → perched water table



Water enters fine-textured soil; vertical and horizontal movement both occur.

Water contacts soil interface; vertical movement stops (perched water table).

Water enters coarse-textured soil only when gravitational pressure overcomes barrier.

Nutrient overload

DO NOT FERTILIZE this soil.

SOIL pH 5.9 NITROGEN: NO3-N = 110 ppm NH4-N = 5 ppm
BUFFER pH 6.5 ORGANIC MATTER: 21.8 % (Desirable range 4-10%)

NUTRIENT LEVELS:	PPM	Low Medium High Very High
Phosphorus (P)	38	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Potassium (K)	430	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Calcium (Ca)	2463	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Magnesium (Mg)	327	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Instead:

- Keep soil texture uniform to optimize water and air movement
- Don't amend soil unless soil test shows less than 4% OM
- Add organic matter as mulch

Poor installation

Myth: Root balls must be left intact during transplanting

Facts:

- Container plants and B&B trees contain media unrelated to local soil
- Many balled-and-burlapped trees are bagged too deeply
- Deformed woody roots will not correct themselves

Instead:

- Remove all materials from root balls to improve root establishment
- Install at grade to ensure root crown is not buried
- Correct root flaws to stimulate new root growth

Poor soil management

Myth: Landscape fabric controls weeds permanently

Facts: Landscape fabric and other sheet mulches

- limit air and water movement
- interfere with roots
- do not stop weeds

Instead: Use arborist wood chips as an effective mulch material

- Begin mulch application before annual weeds establish (spring or fall)
- Remove perennial weeds in spring when root resources are lowest
- Mow perennial weeds at root crown; pulling destroys soil structure
- Maintain thick layers (4-6" for ornamental sites, 8-12" for unmanaged areas) of coarse materials for weed control and water conservation
- Keep mulch away from trunks of trees and shrubs
- Pull any resprouting plants; mulch prevents erosion and facilitates pulling
- Replace mulch as needed to maintain appropriate depth

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Information needed for diagnosing tree damage or failure

1. **Plant and landscape details**
   A. Be sure to have a current soil test prior to any diagnosis or treatment.
   B. Correctly identify the plant. What conditions are needed for it to thrive?
   C. Examine the entire plant and its surrounding environment.
   D. What's been done to the soil in the last several years? Include significant excavations, soil amendments, and fertilizer/pesticide usage.
   E. How was the plant installed? Were all materials removed from the roots? Were poorly structured roots pruned?
   F. What unusual weather events occurred in the last year?

2. **Damage details**
   A. Write down the damage you observe on the plant.
   B. Did the damage appear suddenly (acute damage)?
   C. Did the damage appear slowly (chronic damage)? Chronic damage is usually due to nonliving factors, especially if it recurs yearly.
   D. Nonliving causes MAY be indicated if:
      1. damage is uniform and on more than one plant
      2. damage does not continue to spread throughout the plant or to other plants
   E. Living causes MAY be indicated if:
      1. damage is irregular or random.
      2. damage progressively spreads through the plant or to adjacent plants.

<u>The leading cause of death of urban trees and shrubs is poor management</u>

Cultural reasons for plant stress and death

1. **Younger/recently installed trees (<10 years old)**
   A. Poor quality roots (circling, girdling or kinked roots)
   B. Improper soil amendment
   C. Improper installation (foreign materials not removed from root balls, planted too deeply, etc.)
   D. Improper staking
2. **Existing trees (>10 years old) – all of the above reasons PLUS**
   A. Significant soil disruption
   B. Poor soil health
      i. Compacted
      ii. Use of landscape fabrics, sheet mulches
      iii. No organic mulch
      iv. Overuse of fertilizers/pesticides

Stressed plants may not be dead; wait for a year to see if growth resumes

- Especially true of drought-related stress, where leaves fall prematurely.
- Other tissues are more resistant to water loss and may, with proper care, survive until the following year.
- Many trees and shrubs can be dug up and replanted if they were installed incorrectly, or they are in the wrong location.

Science-based methods for installing and managing resilient trees

- Remove all materials from the roots before planting
- Plant with the root crown at grade
- Do not incorporate anything into the backfill soil
- Apply an arborist wood chip mulch (no sheet mulching!) to protect root zone
- Stake plants only if necessary
- Irrigate well the first season
- Have your soils professionally tested before adding any nutrients
- Avoid pesticide use unless a professional diagnosis recommends doing so
- Protect root zones whenever landscape soils are disturbed