

The impact of environmental stresses on the survivability of trees in the urban landscape

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1.0 Summary of findings

- 11 Key factors
- Don't ignore a healthy root:shoot ratio
- The importance of provenance in species selection
- Most research doesn't actually happen in an urban setting
- The importance of research in hardiness zones 2-5

Key findings

Species selection

Transplanting method

Site selection and preparation

Soil compaction

Moisture stress

Mulching

Salt and de-icing products

Root damage

Light

Temperature

Post-planting management



2.0 Species selection

Provenance and ecotypes



Provenance and ecotypes

- **“Tough trees for tough situations”**
- Source seeds from less than optimal environments when possible
 - Near the limit of a species geographic range
 - Stress prone areas i.e. floodplains
- Be aware of out of country stock
 - Red maple can be grown from hardiness zone 3-11 (Florida to Ontario)

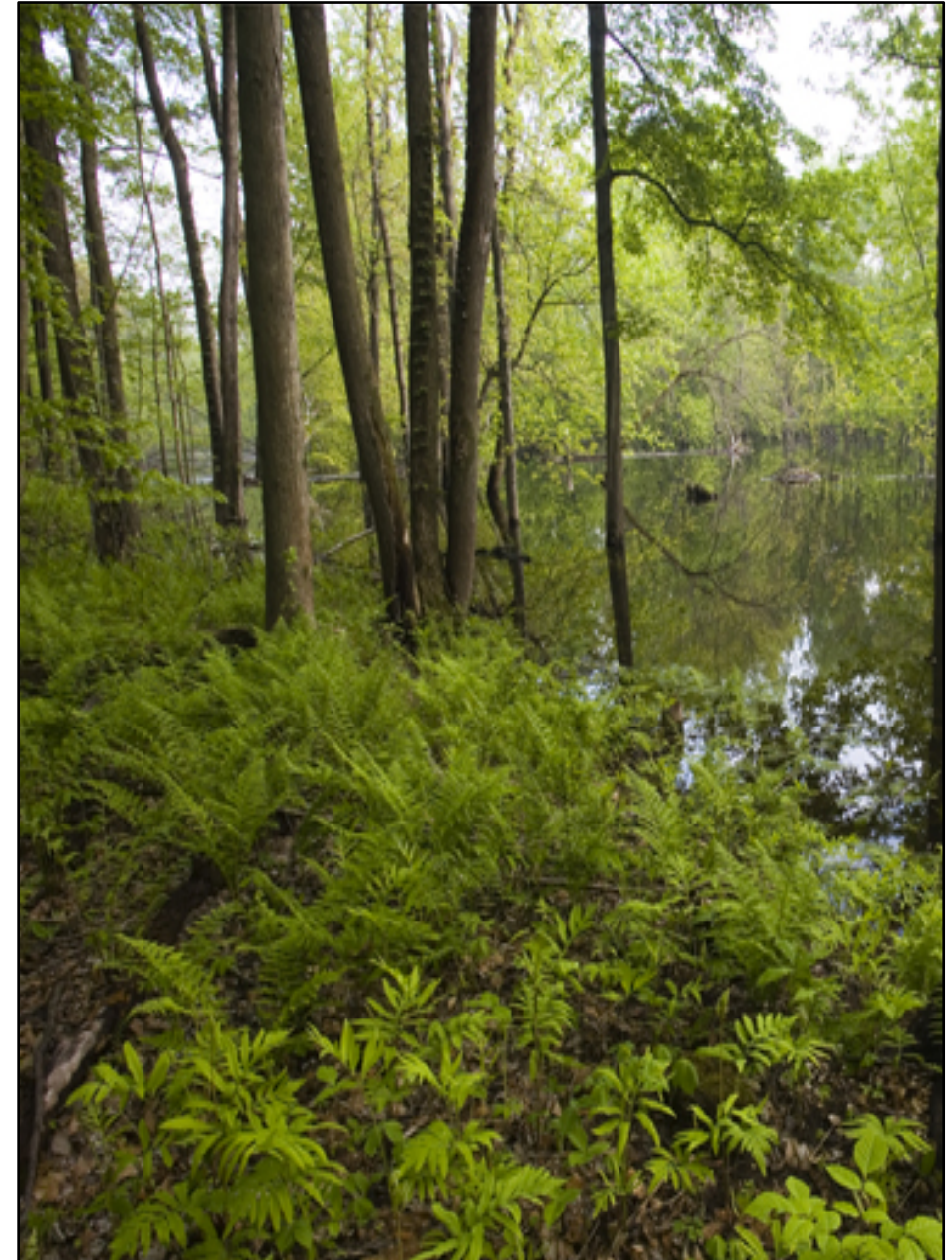


Photo credit: Nature



3.0 Transplanting

Transplant shock

Transplanting date

Transplanting depth

Production method

Soil amendments



Transplanting shock

- “A temporary condition of distress resulting from injuries, depletion, and impaired function”
- Solution 1: Harden off nursery stock
- Solution 2: Pre-conditioning in the nursery



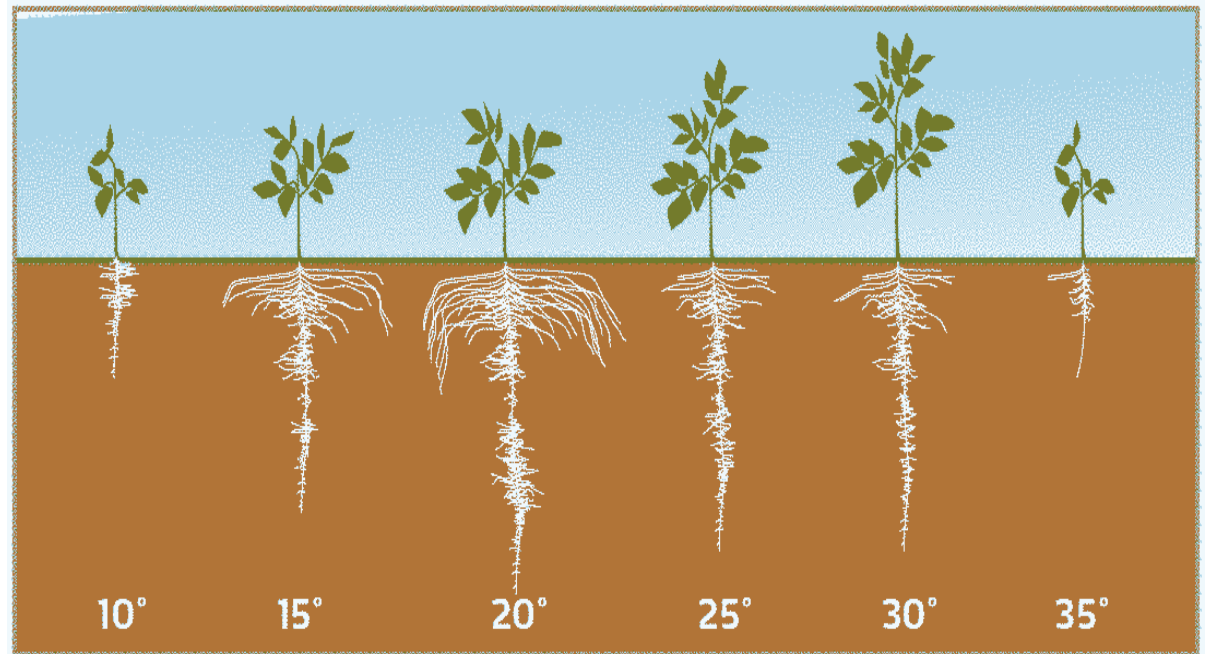
Photo credit: Chase Mendenhall



Transplanting date

- Spring/Fall transplants are popular
 - Less transpirational demand
- Soil temperatures influence root regeneration
 - **Leave time for root regeneration before cold weather**

Effects of Soil Temperature on Root Development



REF: SATTELMACHER ET AL - 1990



Transplanting depth

- Root collar – above or below grade?
 - Interaction with girdling roots and poor drainage
- Stability trade-off?
 - Not always



Production method

Container Production

- Small root ball volume
 - No root damage but can still result in moisture stress
- Containers for deflected roots

Field Production

- Small trees retain a greater % of root ball when dug
- Retaining wire basket at transplant = greater stability



Transplant amendments

- Urban soils aren't the greatest
 - Soil quality is not usually considered in planting contracts
- Mycorrhizae ectofungus
 - Quicker root regeneration (Nitrogen uptake)
 - Less moisture stress
- Bare root hydrogel dip
- Sucrose >25g/L injections
 - Stimulates fine root growth

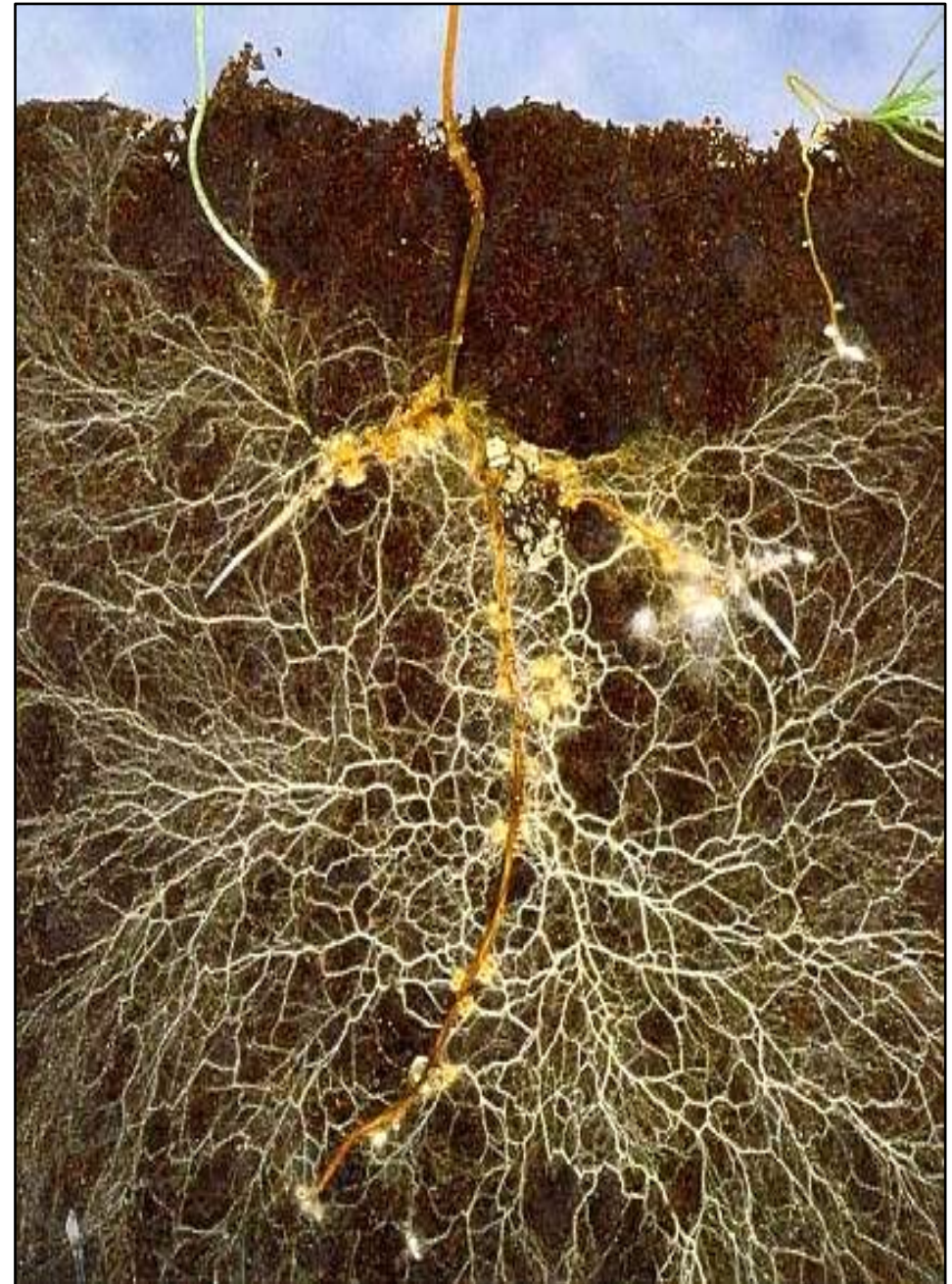


Photo credit: Alberton, O., Kuyper, T (2009)



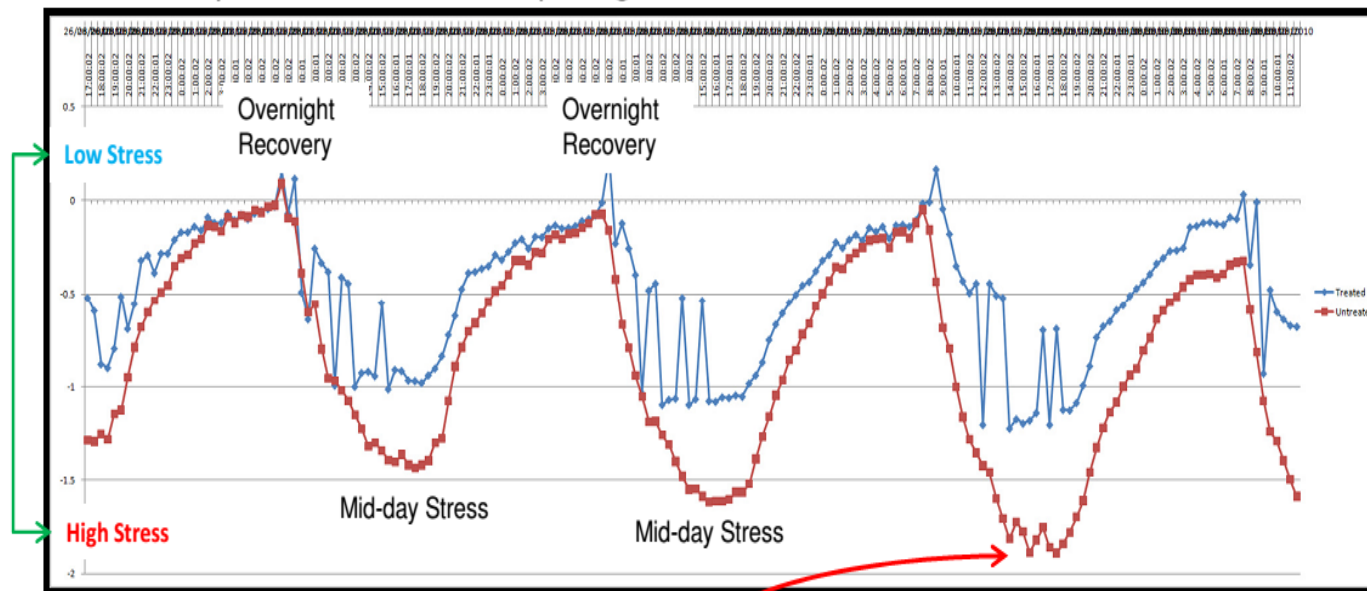
Transplant amendments



Graphing Water Stress - 24/7 - University of Guelph Data

Four Days Without Rain – **The Root Rescue Advantage Revealed**

Stem Psychrometer Data Comparing **Treated** and **Non-Treated** Dawn Redwood Trees



THE DANGEROUS DIP

- **Blue Trees** (treated) = Root Rescue inoculated
- **Red Trees** (control or untreated) = fending for themselves



4.0 Site preparation

Root zone misconceptions

Soil volume

Structural soils

Soil amendments



Root Zone Misconceptions

1. Most trees **do not penetrate deeply into the ground** and 1m of soil depth is sufficient.
2. **Roots tend to grow laterally** rather than vertically, and can spread more than 3 times the diameter of the crown.
3. It is the **fine roots that supply the majority of the water** uptake and not the larger roots.



Soil volume

Trees need adequate space **both above and below** ground

- Minimum of 28m³ quality soil volume is needed
- 80% of all urban tree problems stem from poor soils



Structural soil

Benefits	Compromises
Retain structural and load bearing support	Minimal amount of quality growing soil (~20%)
Increase soil pore size	Water/nutrient limited
Increase rooting space in dense urban areas	Costly



Soil amendments

- Fertility
 - Increase nutrient availability
 - Promote root growth
 - Root:Shoot ratio?
- Organic matter
 - Increase drainage
 - Decrease compaction
 - **Especially important in clay soils**



Photo credit: Jason Henry and Darby McGrath (2016).



Soil Amendments

- Fertilization isn't always necessary/
beneficial
 - **Limiting factor?**
 - 11 species showed no response to different nitrogen levels (up to 2x rate!)
- **Ensure GOOD soil conditions before wasting fertilizer**
- No evidence that commercial backfill amendments actually work

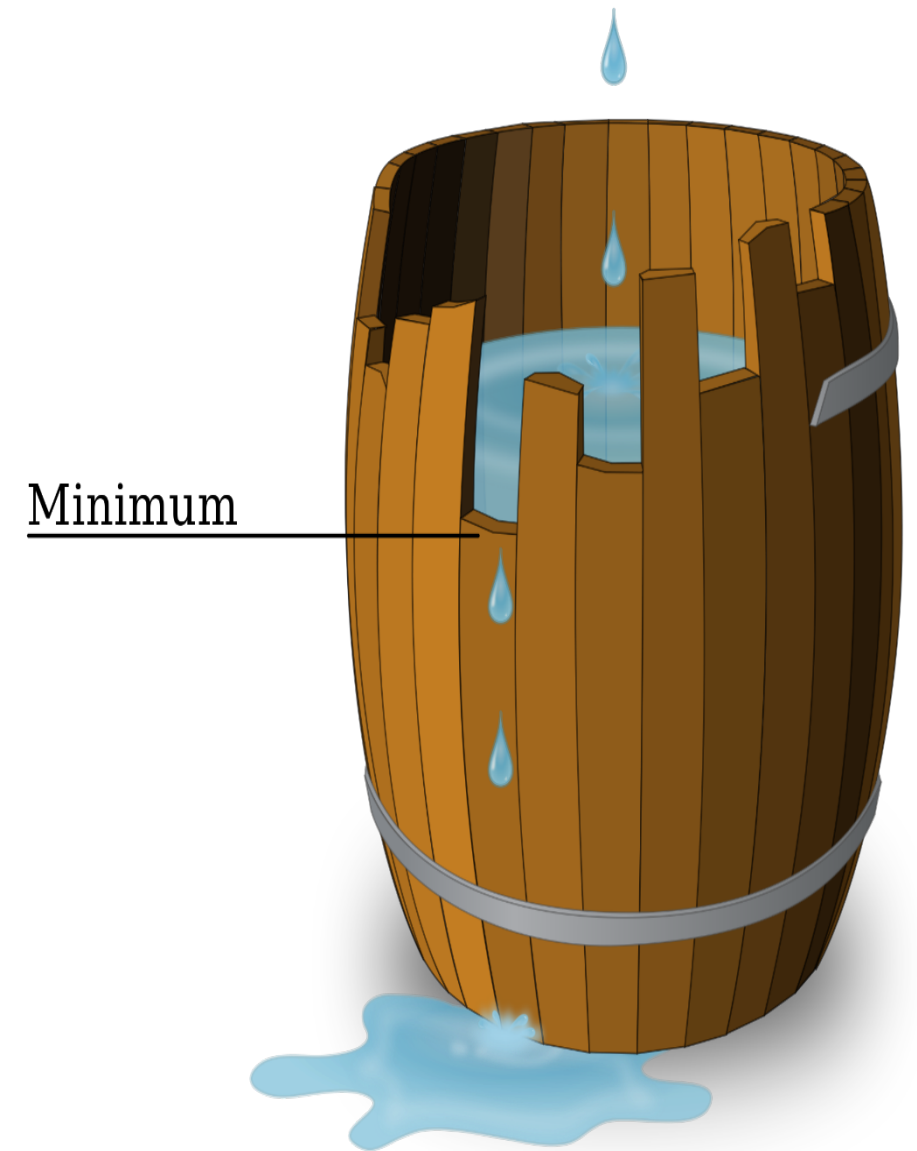


Photo credit: Wikimedia



5.0 Soil Compaction



Soil Compaction

- Think about the soil outside the tree pit
 - At least 12m³ of uncompacted soil in the tree pit
- <1.5g/cm³



6.0 Moisture stress

Drought

Flooding



Drought

- What can cause low infiltration?
 - Soil compaction
 - Small surface area
- **High root:shoot ratio is a drought tolerance mechanism**
- Conditioning trees
 - Mycorrhizae/Hydrogel dips



Flooding

- Decreases soil oxygen levels
- Most methods to deal with soil compaction also work with flooding
 - Make sure the water can drain away
- Deciduous trees are more tolerant than conifers

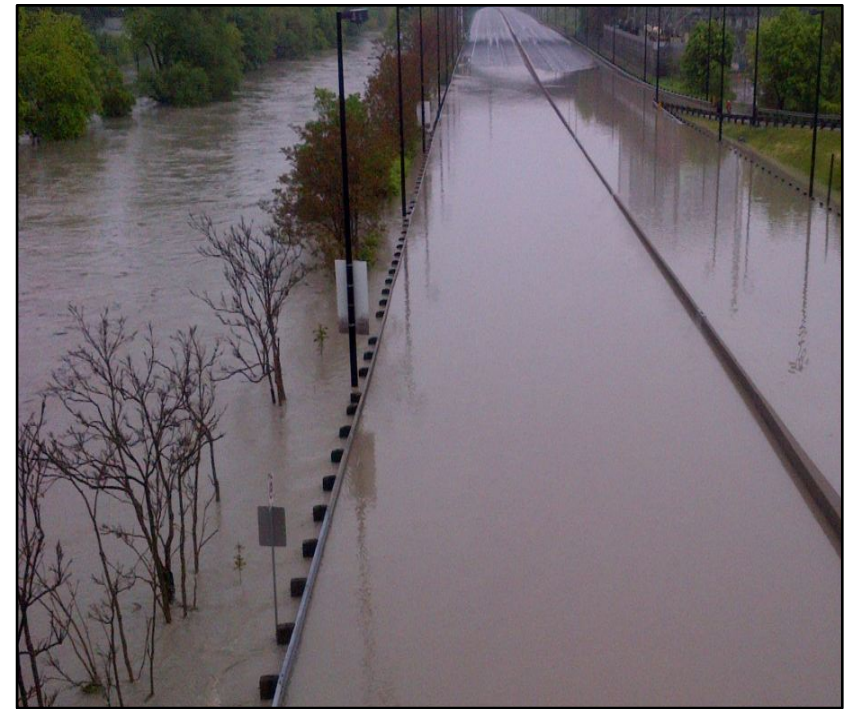


Photo credit: The Weather Network



Photo credit: Dave Buston /AFP/Getty Images



7.0 Mulching



Mulching

- Research is split
 - Florida = negative results
 - Illinois = positive results
 - For coarse mulches
- What about Hardiness zone 2-5?
- **Decreased water infiltration**
- **Decrease weed competition**
 - Keeping the area weed free was shown to be better than mulching
 - Roots remediation? Don't mulch

Mulch Volcano - BAD



Proper Mulching



Photo credit: <http://www.harvestpower.com/how-to-mulch-around-trees/>



Photo credit: <https://forestcitytree.wordpress.com/>



8.0 Salt and de-icing products

Preventative measures

Reparative measures



Preventative measures

- It's not going away anytime soon
- Soil concentration vs foliar deposition
 - Tolerance to one \neq tolerance to the other
 - Species selection based on which form of salt contact is more likely
- Site preparation
 - Lips
 - Buffer zones
 - **Good drainage**



Reparative measures

- Gypsum application to the soil
 - 20-40lbs/100ft²
 - No effect of pH
- Wash the tree and flush the soil
 - Attempt to remove the salt
 - Ensure good drainage
- Site remediation
 - High salt = greater soil compaction



Photo credit: University of Massachusetts Amherst



Photo from: <http://gibneyce.com/13-read-about-dealing-with-disasters.html#Salt>



9.0 Root damage

Root zone misconceptions



Root Zone Misconceptions - Refresher

1. Most trees do not penetrate deeply into the ground and 1m of soil depth is sufficient.
2. Roots tend to grow laterally rather than vertically, and can spread more than three times the diameter of the crown.
3. It is the fine roots that supply the majority of the water uptake and not the larger roots.



Trenching

- Think about where the roots are
 - Visual appearance isn't good enough
 - Roots grow straight for ~0.5m then deflect
- Fertilize and irrigate prior to root zone excavation



Photo credit: Trees Unlimited LLC



Photo credit: Preservation Tree Services



10.0 Light



Effects of light

- Goal of >80% total light for optimal growth
- Avoid street lights when possible
 - Retain leaves longer = later dormancy
 - Increased chance of root disturbance



Photo credit: Florida Atlantic University



11.0 Temperature



Temperature effect

- Soil under pavement can be $>34^{\circ}\text{C}$
 - Unpaved soils can be 10°C cooler
- Sunscald
 - Highest risk first winter after transplant



Photo credit: Robert Cox



12.0 Post planting management

Determining a tree's needs

What can you do?

Imaging technology



Determining a trees need?

Visual assessment

- Any good indicators?
 - Levinsson et al., 2015 (red oak)
 - Not a good tool for water stress
- Nutrient stress is much more visible

Technical tools

- Starch content
 - Cambial electrical resistance
 - Bark chlorophyll fluorescence
 - Soil sampling
-
- **Expensive and technical skills needed**



Determining a trees needs - Irrigation

- Irrigation IS necessary
 - Growth increase in a year when precipitation was 17% above the 30 year average
- Frequent small irrigation > Few large irrigation
- Infiltration and soil volume
 - How much water is getting to the root zones
 - How much water can these root zones hold



Determining a trees needs - Fertilization

- Research suggests **fertilization isn't necessary**
- Soil fertility is important
 - Urban soils are typically very poor
- Compost and other soil amendments
 - **To improve physical and chemical soil characteristics**



What can you do?

Irrigation

- Frequent smaller irrigations
- Soil moisture sensors
- USDA hand test

Fertilization

- Wait until twig growth
- Soil tests
- **Use high quality soils**



25-50 percent available
1.6-0.8 in./ft. depleted

Slightly moist, forms a weak ball with rough surfaces, no water staining on fingers, few aggregated soil grains break away.



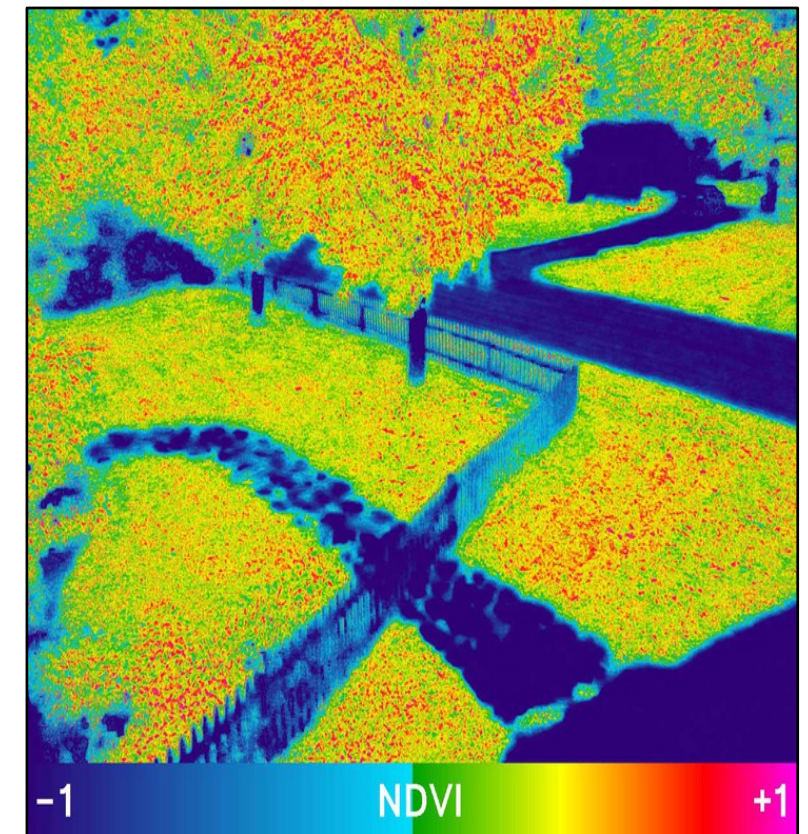
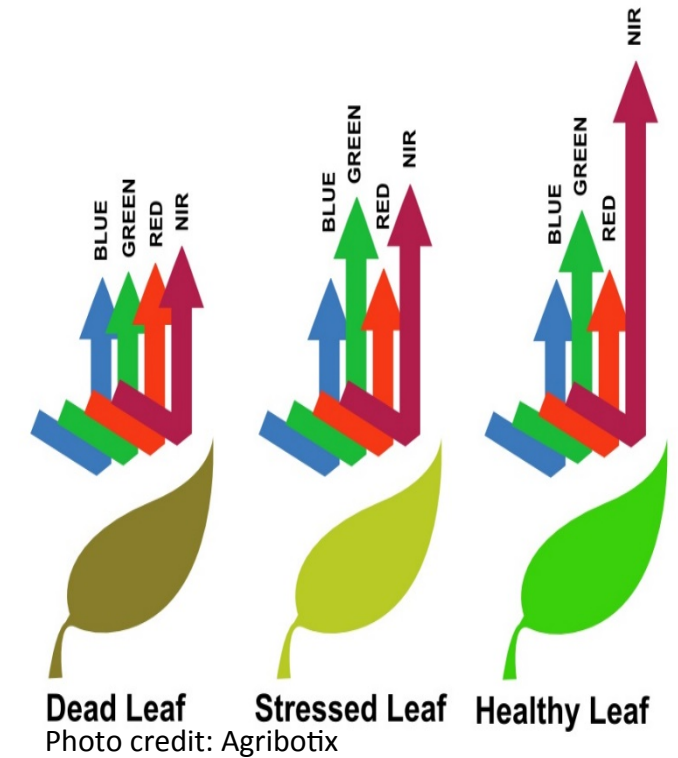
50-75 percent available
1.1-0.4 in./ft. depleted

Moist, forms a ball, very light staining on fingers, darkened color, pliable, forms a weak ribbon between the thumb and forefinger.



Imaging and drones

- Thermal imaging
 - Has been used in Forestry
- Vegetative index
 - Has been used in various agricultural crops (e.g. cotton, wheat)
 - Slight changes in chlorophyll/leaf colour
- This is new technology that can be looked at for urban landscapes



13.0 Research priorities



Research priorities

- Environmental tolerances of tree species
 - Specifically common urban trees in our area
- Effect of mulching in our hardiness zones
- Soil amendments for healthy soil
- Drones and imaging technology



Conclusions

- Don't ignore a healthy root:shoot ratio
 - **These trees aren't bonsais**
- Research in an urban settings if possible
 - University campuses
- The importance of provenance in species selection
 - Ecotype/cultivars are important
- Prioritize research from hardiness zones 2-5 when possible

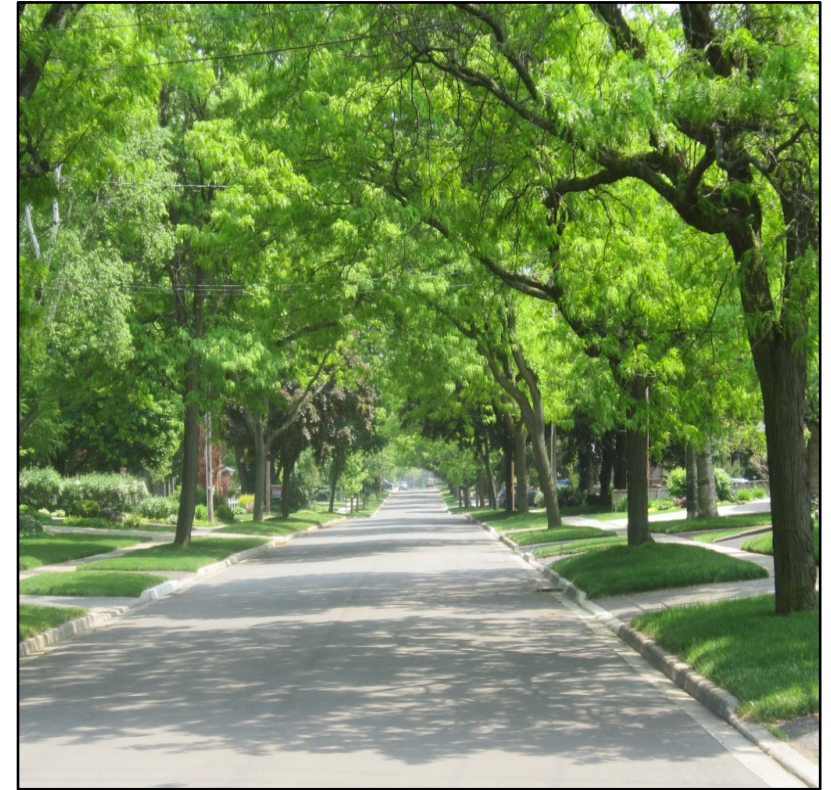


Photo credit: Burlington Gazette

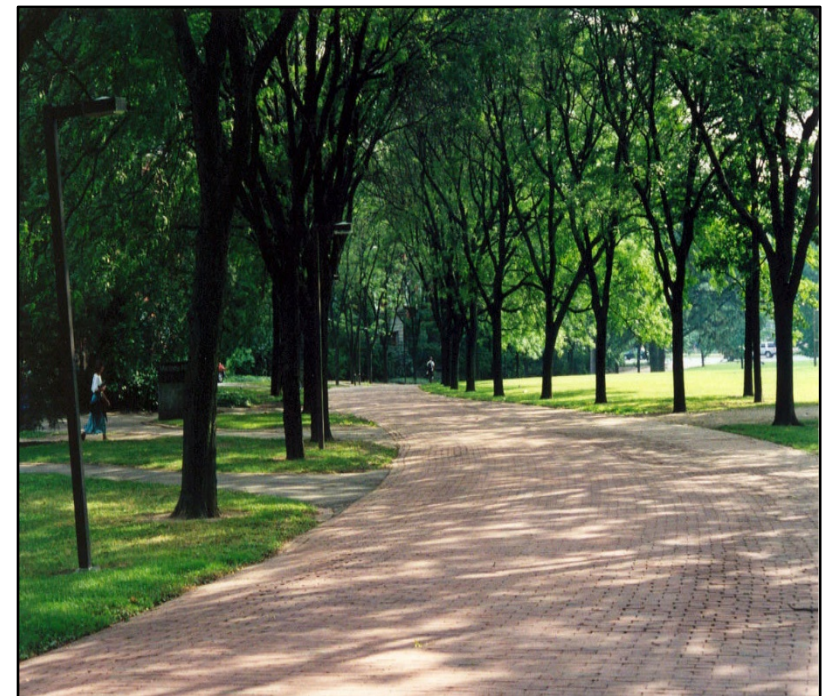


Photo credit: Randy Oldham



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VISTA

Science & Technology

Putting research into action