Managing the Growing Environment for Woody Plants
Soils
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Good Urban Forests Are Not Natural, They are Created
They Always Start With The Right Soil
Where Are You Planting Trees?

Where Can You Find The Right Soil?
What is topsoil?

The "stuff" on top?
"I can't describe it, but I know it when I see it"
A soil profile (Weber County)
Topsoil-subsoil characteristics
Cache County forest soils
Forest vs. landscape soils
Forest litter layers and mulches

Litter layers	Mulches
insulate	insulate
nutrient source	nutrient source
reduce competition	reduce weeds
water conservation	water conserv.
aeration	aeration
other?	other?

The main points:

- Topsoil is available in ***limited supply***
- In most cases, subsoil is not a satisfactory replacement for true topsoil
- Seek out true topsoils for landscapes

"An ounce of prevention is worth a pound of cure"

Topsoil quality guidelines

- Key chemical and physical properties:
  - soluble salts
  - pH
  - texture
  - organic matter
  - Sodium Adsorption Ratio (SAR)

Soil salinity
Soil salinity = soluble salts in soil

- Salts inhibit plant growth
- Salts cause "chemical drought" - equivalent to induced water stress
- Visual diagnosis: salt crusting/salt burn
- Soil test diagnosis:
  - Electrical conductivity (EC) is the measure of soil salinity.
- EC > 2 deciSiemens/meter is a saline soil for horticulture uses
- EC > 4 deciSiemens/meter is saline for ag.

Sources of salts

- Residual salts in new development areas
- Irrigation waters
  - natural sources?
  - water softeners?
- Deicing salts (road throw and sidewalk)
- Over-application of fertilizers and/or manures and composts

Solutions to salt problems

- Control the source
  - History, water, fertilizer, manure runoff, other?
- Select salt tolerant vegetation
  - Salt prone areas
  - Salt prone landscapes
- Clean up the problem

– Remove salts by leaching with water

Salinity and plant adaptation

Berries

Apple

Alfalfa---|

Corn----|

Spinach----------|

Bluegrass

Tall fescue----------|

Alder

Cottonwood----|

Barley----------|

Wheatgrass----------|

Leaching salts with water

- Ensure that soil has good internal drainage. Water must move through the soil to carry salts out

– Add organic matter

– Deep tillage/ripping

- Apply water over 1-2 days

– 6 inches of water to cut EC by 50%

– 12 inches of water to cut EC by 80%

– 24 inches of water to cut EC by 90%

Soluble salts

- Electrical conductivity of the solution extracted from soil

- Guidelines:

– Ideal: < 2 dS/m or mmho/cm

– Acceptable: < 4 dS/m or mmho/cm

– Unacceptable: > 4 dS/m or mmho/cm

Tree tolerance to soil salinity

- ?

- Very few studies on tolerance to soil salinity

- Most studies on tolerance to salinity on foliage (salt spray)

- "Ideal: topsoils are okay for most trees

Treatment of salinity problem

- Select tolerant species and varieties

Treatment of salinity problem

- Increase drainage through soil

Treatment of salinity problem

- Leach soil with clean water to wash salts lower into profile, or out of profile

Salt Damage

Salt Damage

Soil pH

Soil pH

- Soil pH: the degree of acidity or alkalinity of soil

- The pH scale:2 4 6 8 10 12

pH (alkalinity)

- The degree of acidity or alkalinity (basic nature) of soil

- Guidelines:

– Ideal: between 5.5 and 7.5

– Acceptable: between 5.0 and 8.2

– Unacceptable: below 5.0 or above 8.2

Acidic Loving Azaleas, Rhododendron, Magnolias

Alkaline Loving Juniper, Russian Olive, Salt Cedar And Halogeton

Soil pH and nutrient availability

Treatment of high pH problem

- Select tolerant species and varieties

- Try amending soil with acidic organic matter or elemental sulfur

- Good luck

Jordan River Temple

Jordan River Temple
Changed pH from 8.2 to 7.5 in 25 years in the flower beds
No Practical Way to Change Soil Once Trees are Planted
Major pH problem: iron chlorosis
Manganese Deficiency
Zinc Deficiency
Soil texture
Soil texture

- The percentage (by weight) of sand-, silt-, and clay-sized particles in soil
- Guidelines:
  - Acceptable percentages:
    - less than 30% clay, and
    - less than 70% sand, and
    - less than 70% silt

Soil texture classes

- Class guidelines:
  - Ideal: loam, silt loam
  - Acceptable: sandy clay loam, sandy loam, clay loam and silty clay loam
  - Unacceptable: clay, sandy clay, silty clay, silt, sand, loamy sand

Soil texture

- The relative proportion (percent) of sand, silt and clay in soil
- Refers to individual or primary soil particles left after structure is removed

The effect of particle size
Determining soil texture

- By feel
- Soil test
- Using the jar method
  - Fill a 1 quart jar ¼ full of soil
  - Fill the jar up to ¾ full of water
  - Shake very well to suspend soil
  - Place on a flat surface and allow soil to settle

Qualitative indicators of topsoil quality

- Visual appearance
- Feel when wet and dry

Visual appearance

- Do you see salt crystals on the surface?
  - high salinity problem
- Is soil white or light in color?
  - low organic matter
  - high lime
  - high salt

Feel

- Wet:
  - sticky? too much clay
  - gritty? too much sand
  - generally, does it feel right?
- Dry:
  - too hard to crush? low organic matter or high clay

Treatment of texture problem

- Select species tolerant of:
  - drought if soil is coarse (“sandy”)
  - poor drainage if soil is fine (“clayey” or “silty”

- Few treatments for wrong soil texture
  - add large quantities of organic matter

Organic matter

- The percent organic matter in a soil (by weight)
- Guidelines:
  - Ideal: greater than or equal to 2%

– Acceptable: greater than or equal to 0.5%
– Unacceptable: less than 0.5%

The effect of organic matter

Correcting low organic matter

- Add high quality organic matter
  – composts
  – sawdust
  – wood chips
  – bark
  – rice hulls
  – grain straw

The Best Amendment for Trees is What They Drop

Soil Depth

Oregon forest soil profiles

Soil Structure

Soil Structure is One of the Few Aspects of Your Soil Condition You Can Change

Soil structure

- The combination of sand, silt and clay (with organic matter) into secondary particles called *aggregates*

Structured or not?

Amending soils with organic matter

– improves drainage of high clay soils
– improves sandy soil water-holding capacity
– reduces compaction
– provides nutrients to plants
– improves soil "tilth" (ease of tillage, working with a soil)
– lowers soil pH

How much should I add?

- How much is already there?
  – Native Utah soils ~ 0.25 to 2.0%
  – Ideal soils 5-10%
- Are you satisfied with the current condition of your soil?
- Don't Learn to live with it!
- Add organic matter to maintain soil conditions

Ways to add/preserve organic matter

- Grow plants
  – plants put organic matter back into soil with roots and leaf litter
- Mulch around trees - organisms will incorporate the organic matter for you
- Add extra organic matter to the entire area, not just the planting hole

Sources of organic matter

- Wood residues
  – chips/sawdust/bark materials persist but need extra nitrogen to prevent tie-up (1 lb of nitrogen per 100 lbs of material)

Sources of organic matter

- Grass or leafy green residues
  – can't go wrong with these

Sources of organic matter

- Composts and animal manure
  – good sources of organic matter and nutrients
  – watch for salts and weed seeds
  – Biosolids

Add Leaves

How much OM should I add

- Single application
  – 1 (one) inch per year for normal applications in annual areas
  – 2-3 inches of low salt material if you are in dire need of organic matter (a new site needs significant improvement)
- 1 inch of material = 3 cubic yards spread over a 1000 square foot area

Soil Compaction Impacts on Trees

Compaction Problems for Trees

Compaction Problems for Trees

- Causes of soil compaction
- The impact on landscapes

- The root of the problem
- Prevention
- Treatment

Causes of soil compaction
Causes of compaction

- Soil Compression by:
  - vehicle traffic
  - foot traffic
  - water (sprinklers)
- Passive vibration forces (street, mass transit traffic, construction equipment)

The Impact on Trees
The impact on trees

- Vegetation declines
  - Visual impacts
  - Economic impacts
- Water runoff and erosion - urban nonpoint source pollution

Common problem in high use areas and most home landscapes
The root of the problem
The root of the problem

- Reduced aeration
  - plant smothered by lack of oxygen to the roots
- Reduced water-holding capacity of soils
  - water stress
- Physical impedance to root growth

The ideal soil (% by volume)
The compacted soil
How much is too much?

- Plant growth is severely restricted when <u>air space</u> <10% of total soil volume
  - highly compacted soil
  - over watered, moderately compacted soil

Prevention
Preventing compaction

- Restricting traffic
  - signs
  - fencing
  - landscape design opportunities
- sidewalks
- shrubs
- walls

Preventing compaction

- Treatments
  - Grates
  - Brick
  - Stay out of Planting Areas

Preventing compaction

- Compaction-resistant soils
  - sandy materials - sandy loam/loamy sand textures, fine sands resist compaction
  - high organic matter induces the formation of soil structure

Treating compaction
Treating compaction

- Dynamite? - early 1940s technique
- Add organic matter
- Ripping - deep compaction
- Roto-tilling - shallow compaction
- Aeration/aerating - shallow compaction
  - hollow tine implements are best

Deep ripping or subsoiling

- Recommended for construction sites before establishing landscape

Mulching

- Surface mulch for trees and trails
- Vertical mulch for trees:

– Vertical holes 3-4 inches in diameter
– Backfill with coarse gravel or wood chips
– Provides outlet for water flow from root zone; improves deep watering and aeration

Jetting

- Injecting water or air under high pressure to fracture soil
  - Hydrojet injects water
  - Terrajet injects air
- Mixed results with these units, but may be only option for deep compaction

Soil drainage

Poor drainage problem

- Add organic matter
- Consider installing a subsurface drainage system (tile drain)
- Consider drainage ditches
- Compaction?
- Consider raised beds
- Precise water management

Poor Drainage = Dead Plants

Poor Drainage = Dead Plants
Poor Drainage = Dead Plants

Excessive drainage problem

- Very sandy soil
- Add extra organic matter
- Precise water management

Precise water management

Tree on left not irrigated, tree on right adequate irrigation for 7 years