Science-based soil management for urban trees

Overview of seminar

- Plant-soil systems, goals, and appropriate management
- The myth of organic amendments
- Urban tree management tips

Landscape goals determine management

Differences among systems

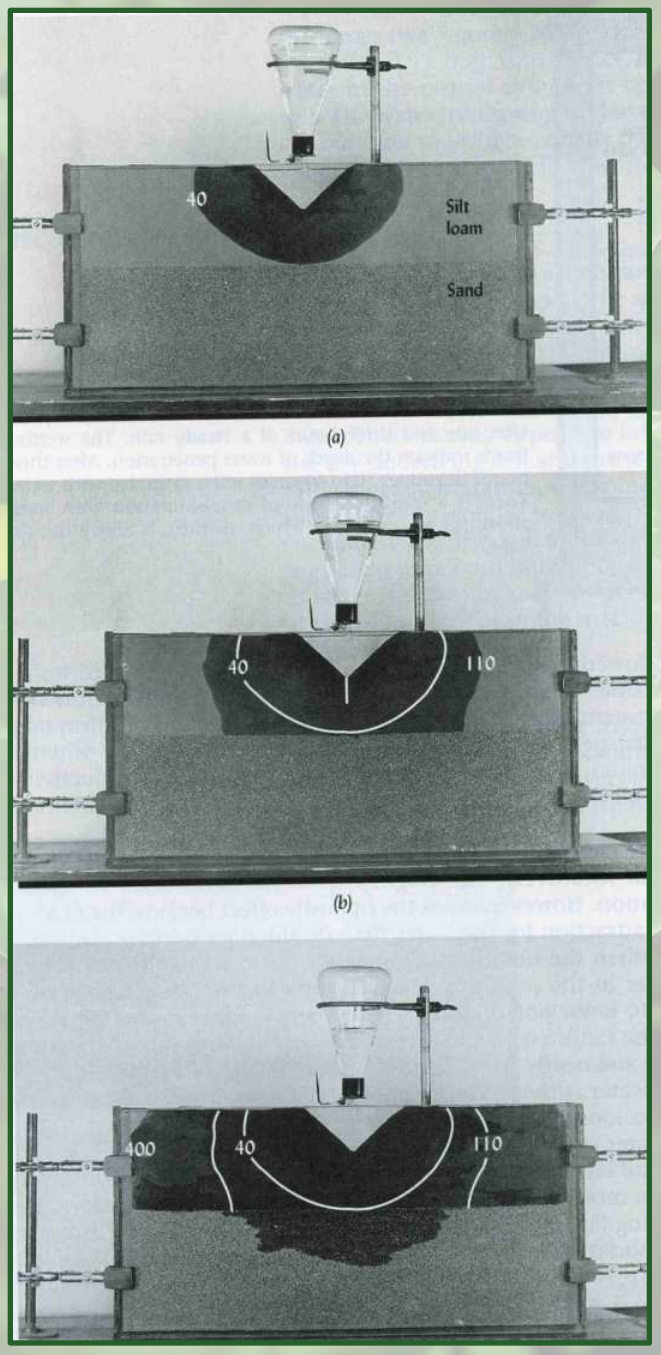
Comparative criteria	Intensive agriculture	Home vegetable garden	Ornamental landscape
Plant life cycle	Annuals	Annuals/perennials	Woody plants and perennials
Planting scheme	Monoculture	Polyculture	Permanent landscape
Biomass removal	High	Moderate	Low
Soil disturbance	High	Moderate	Low
Nutrient inputs	High	Moderate	Low
Disease pressure	High	Moderate	Low
Pest pressure	High	Moderate	Low
Biodiversity	Low	Moderate	High
System goal	Maximize yield	Crops for personal use	Sustain a permanent landscape

Avoid amending soils!

- Amendment and mulching differ
  - Amendment = work into soil
  - Mulching = lay on top of soil
- Incorrect system goal
- Soil structure and functionality disrupted

Soil amendment will cause

- Hydrology disruption
- Soil subsidence
- Nutrient overload

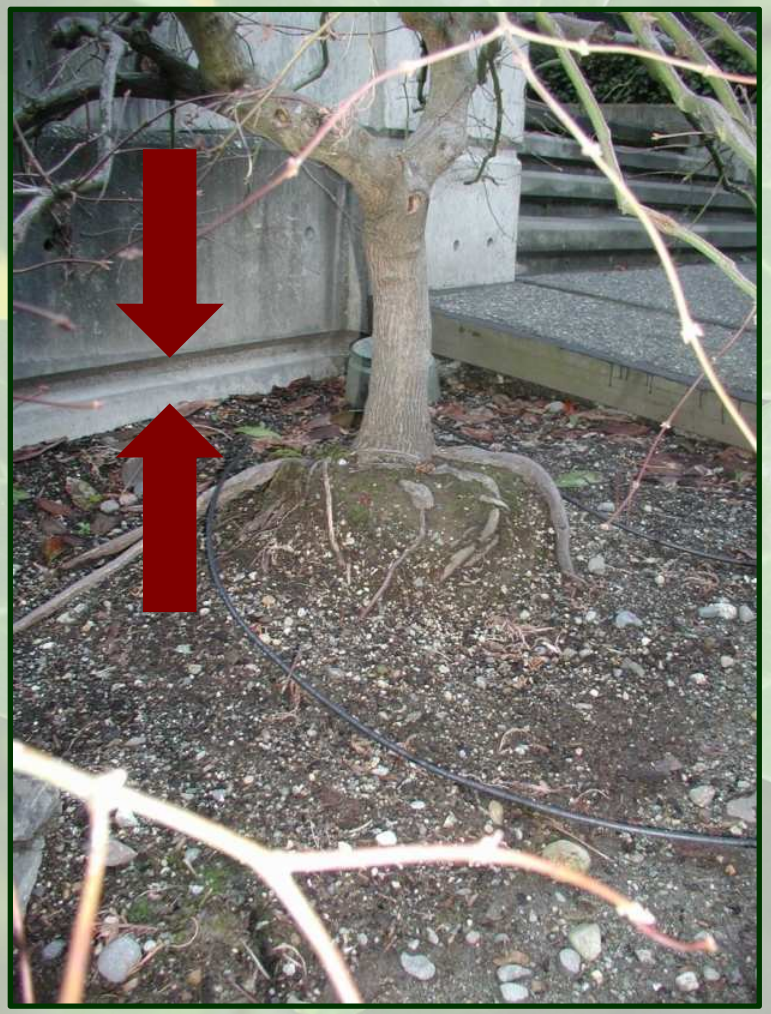


Water enters fine-textured soil; vertical and horizontal movement both occur

Water contacts soil interface; vertical movement stops

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

Subsidence



- OM decomposes
- Soils subside

Excessive nutrients

Excessive levels of some nutrients can cause deficiencies of others

Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	6.7	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	45.2	4-14
Potassium (K)	436	100-160
Calcium (Ca)	2269	1000-1500
Magnesium (Mg)	391	50-120
Sulfur (S)	21.0	>10
Micronutrients *		
Boron	0.4	0.1-0.5
Manganese (Mn)	5.5	1.1-6.3
Zinc (Zn)	9.8	1.0-7.6
Copper (Cu)	0.2	0.3-0.6
Iron (Fe)	4.2	2.7-9.4
Aluminum (Al)	12	<75
Lead (Pb)	0.7	<22

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Opt range found in soils and are for reference only.*

Sustainable levels of OM

- Natural additions
  - Death of soil organisms
  - Natural incorporation from surface
- Natural subtractions
  - Decomposition by microbes
  - Uptake by plants
- Net OM = sustainable
- *This will vary from site to site*

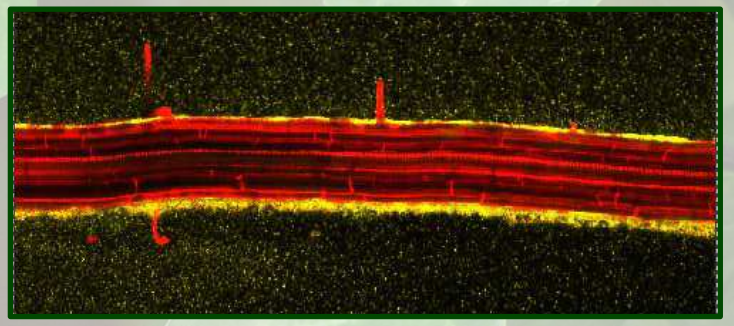
Instead of amending, apply mulch

- Little soil disturbance or compaction
- Protects soil environment
- Reduces weeds

Tree management tips

Consider root requirements

- Water
- Nutrients
- Oxygen
- Microbial partners



Identify factors that impair soils




- Layered soil – poor water and oxygen movement
- Amended soil – poor water and oxygen movement
- Compacted soil – low water and oxygen levels
- Sheet mulched soil – poor water and oxygen movement

Let soil tests guide fertilizer use

Results

Analysis	Value Found	Optimum Range	Analysis	Value Found	Optimum Range
Soil pH (1:1, H2O)	4.9		**Cation Exch. Capacity, meq/100g**	20.4	
Modified Morgan extractable, ppm			**Exch. Acidity, meq/100g**	12.6	
Macronutrients			**Base Saturation, %**		
Phosphorus (P)	3.4	4-14	Calcium Base Saturation	32	50-80
Potassium (K)	146	100-160	Magnesium Base Saturation	4	10-30
Calcium (Ca)	1291	1000-1500	Potassium Base Saturation	2	2.0-7.0
Magnesium (Mg)	109	50-120	**Scoop Density, g/cc**	1.03	
Sulfur (S)	20.8	>10	**Optional tests**		
Micronutrients *			Soil Organic Matter (LOI), %	12.8	
Boron (B)	0.3	0.1-0.5			
Manganese (Mn)	4.3	1.1-6.3			
Zinc (Zn)	8.9	1.0-7.6			
Copper (Cu)	0.4	0.3-0.6			
Iron (Fe)	6.5	2.7-9.4			
Aluminum (Al)	323	<75			
Lead (Pb)	2.5	<22			

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation

Nutrient	Very Low	Low	Optimum	Above Optimum
Phosphorus (P):				
Potassium (K):				
Calcium (Ca):				
Magnesium (Mg):				

Results

Analysis	Value Found	Optimum Range	Analysis	Value Found	Optimum Range
Soil pH (1:1, H2O)	6.7		**Cation Exch. Capacity, meq/100g**	19.3	
Modified Morgan extractable, ppm			**Exch. Acidity, meq/100g**	3.7	
Macronutrients			**Base Saturation, %**		
Phosphorus (P)	45.2	4-14	Calcium Base Saturation	59	50-80
Potassium (K)	436	100-160	Magnesium Base Saturation	17	10-30
Calcium (Ca)	2269	1000-1500	Potassium Base Saturation	6	2.0-7.0
Magnesium (Mg)	391	50-120	**Scoop Density, g/cc**	1.02	
Sulfur (S)	21.0	>10	**Optional tests**		
Micronutrients *			Soil Organic Matter (LOI), %	8.7	
Boron	0.4	0.1-0.5	Nitrate-N (NO3-N), ppm	4	
Manganese (Mn)	5.5	1.1-6.3			
Zinc (Zn)	9.8	1.0-7.6			
Copper (Cu)	0.2	0.3-0.6			
Iron (Fe)	4.2	2.7-9.4			
Aluminum (Al)	12	<75			
Lead (Pb)	0.7	<22			

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation

Nutrient	Very Low	Low	Optimum	Above Optimum
Phosphorus (P):				
Potassium (K):				
Calcium (Ca):				
Magnesium (Mg):				

Phosphorus is excessive!!!

Be cautious with nutrients

- Add readily available nutrients only if soil tests confirm deficiencies
  - Fertilizer
  - Rich organic material
- Add nothing that contains nutrients that are in excess
- Any nutrient addition should be made to the soil surface and covered with woody mulch

Use arborist wood chip mulch

- Provide nutrients and organic matter
- Protect and enhance soil ecosystem health


Questions?

Science-based Soil Nutrition for Urban Trees

Seminar roadmap

- Differences between planting systems
- The myth of organic amendments
- Science-based alternative practices

Differences among planting systems

Comparative criteria	Intensive annual agriculture	Home vegetable garden	Ornamental landscape
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System goal	Maximize yield	Crops for personal use	Sustain a permanent landscape

Myth: "Incorporate plenty of organic matter to create a healthy soil"

- Practice will damage soil structure and function
- Natural soil systems contain a sustainable amount of organic material (OM)
  - Additions (from soil biota death and natural incorporation of surface resources)
  - Subtractions (from use by plants, detritivores, and microbes)
  - Net = sustainable levels; remains consistent year to year
- Therefore, there is no "ideal" %OM for a landscape; however:
  - Ideal soils are generally half solids and half pore space
  - Pore spaces are macropores (filled with air) and micropores (filled with water)
- Only repeated soil testing can establish the sustainable %OM
  - Excessive nutrient levels indicate excessive use of organic matter and/or fertilizers
  - Optimal levels of nutrients indicate that %OM is sustainable
- What's wrong with "above optimal" levels of nutrients?
  - "Above optimal" is actually toxic
  - Excessive nutrients can
    - interfere with uptake of other nutrients
    - Inhibit beneficial soil microbes like mycorrhizae
    - Contaminate aquatic ecosystems

What to do instead: Action items for landscape professionals

- Determine your goals for your landscapes and manage them correctly
- Understand you cannot change the character of your soil with amendments
- Have at least one soil test to determine baseline nutrient levels and %OM
- Use your soil test results to inform use of any fertilizer
- Apply wood chip mulches as a sustainable source of soil OM and nutrients

For more information:
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Email: lindacs@wsu.edu
URL: http://www.theinformedgardener.com (white papers on many of these myths)
Blog: http//www.gardenprofessors.com
Books: http//www.sustainablelandscapesandgardens.com
Facebook page: http://www.facebook.com/TheGardenProfessors
Facebook group: https://www.facebook.com/groups/GardenProfessors/
Publications: https://www.researchgate.net/profile/Linda_Chalker-Scott/publications