Soil Management for Urban Trees – Part 2: Actions

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TREE Fund Webinar

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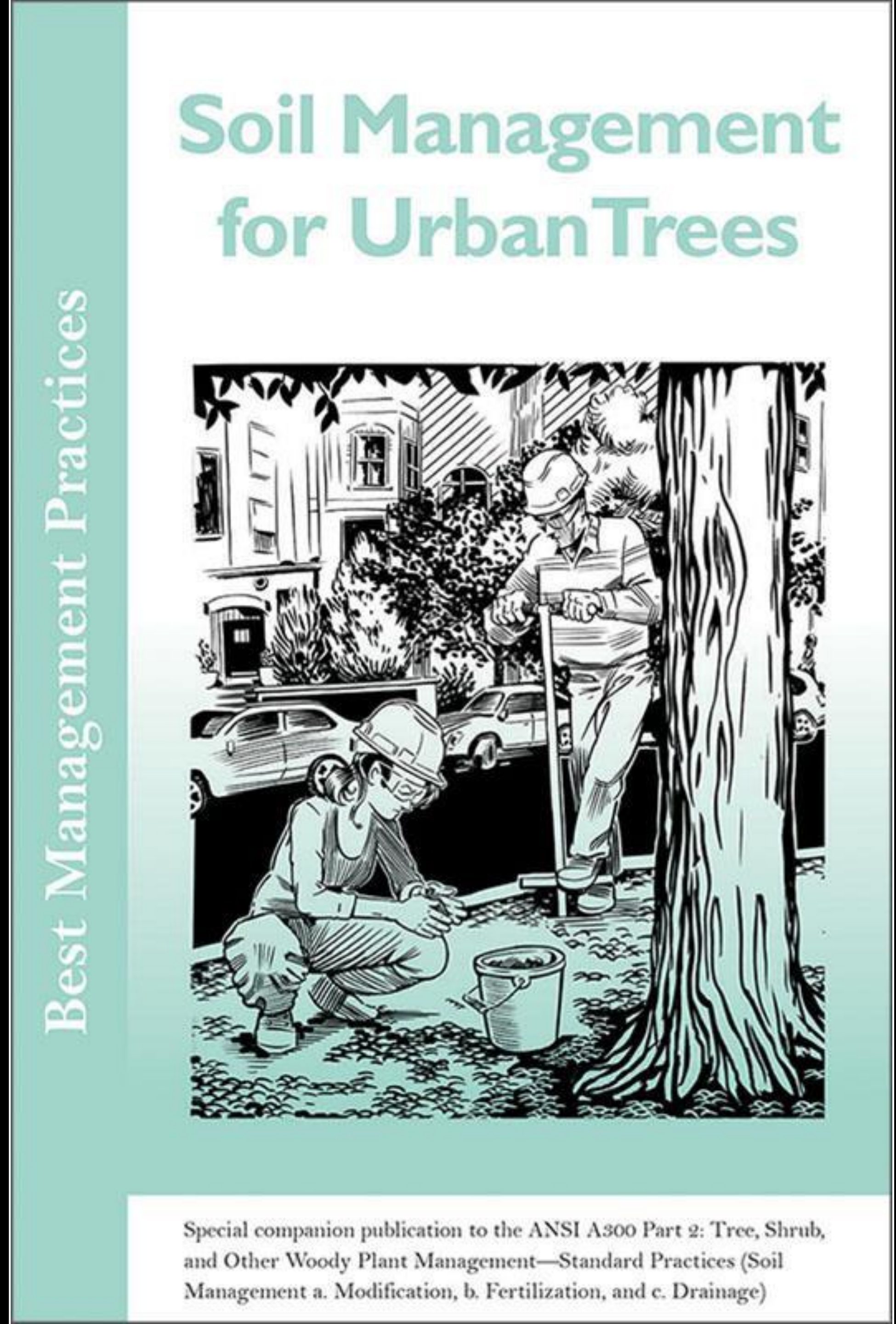
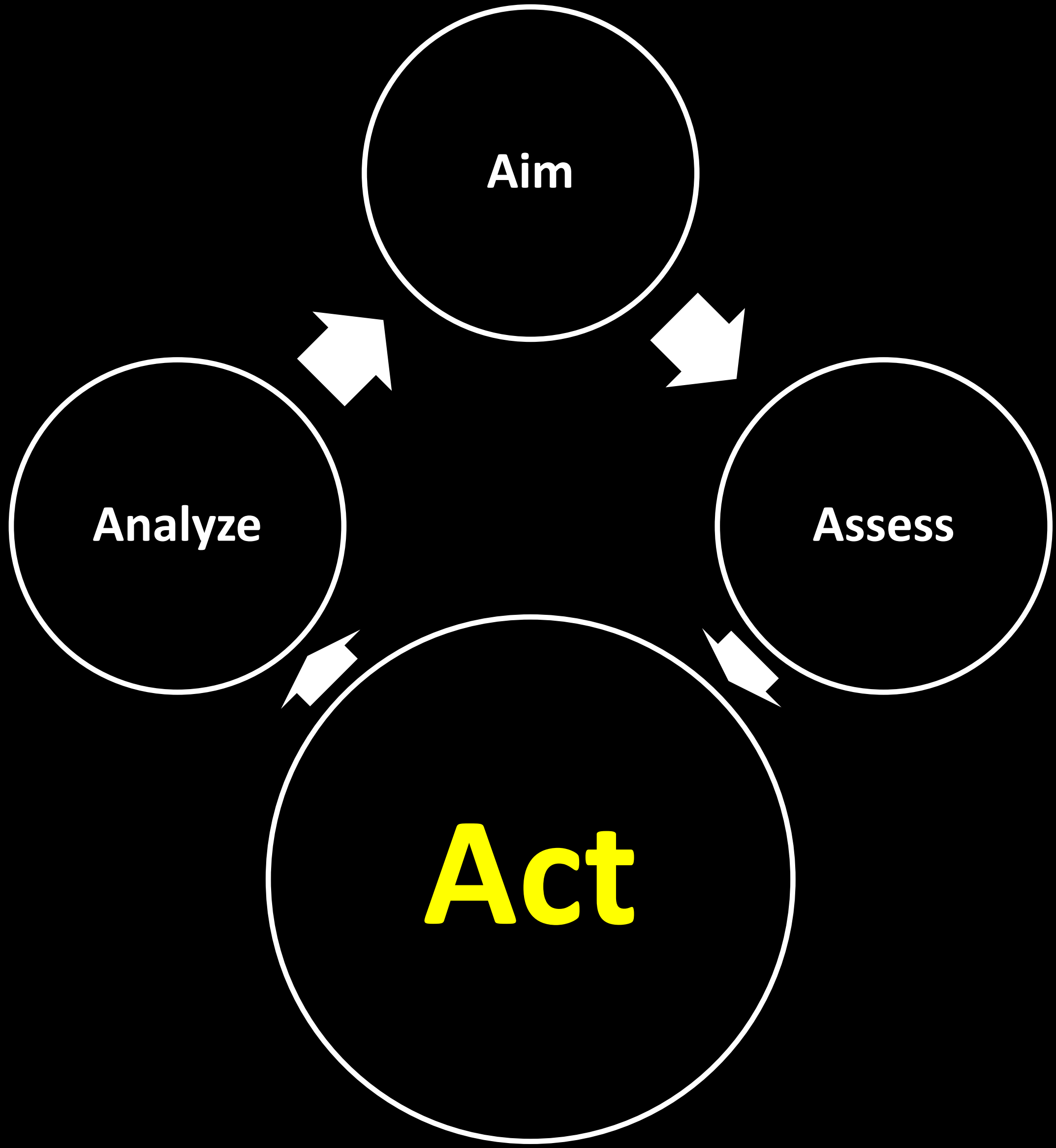
Learning objectives

1. Learn how to manage compacted soils for urban trees
2. Learn how to manage soils that are too wet and too dry for urban trees
3. Learn how to manage soil fertility for urban trees

(Scharenbroch et al., 2014)

Available at International Society of Arboriculture





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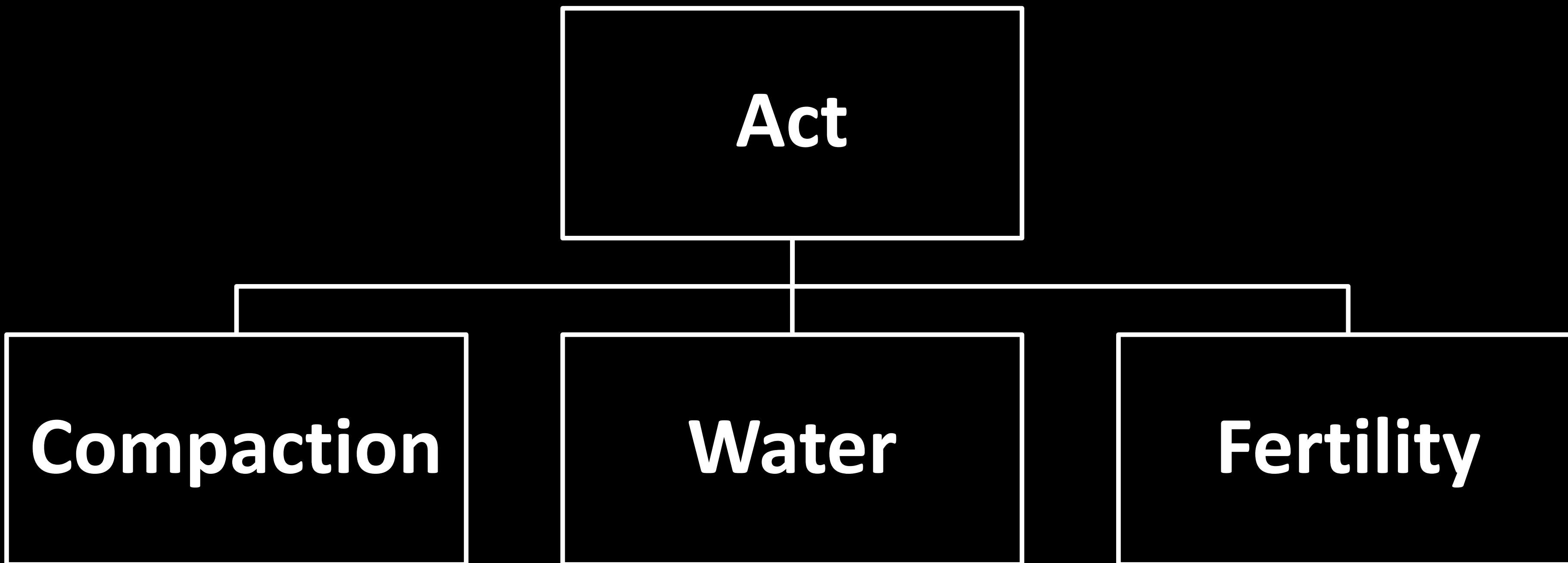
Actions

- **Q1: What are the most challenging urban soil problems for the trees you manage?**
  - **A) compaction**
  - **B) too much or too little water**
  - **C) nutrient limitation**
  - **D) all of the above**
  - **E) none of the above**



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Compaction

- **Soil management for urban trees Part 1: Assessment**
  - Why are urban soils dense?
  - What are the problems associated with compacted urban soils?
- **What can we do about urban soil compaction?**

Compaction BMPs

What can we do about urban soil compaction?

- **Right species for the right site**
- **Prevent and protect**
- **Tillage**
- **Organic amendments**

Right species for the right site

Q2: Which tree would you plant in a compacted urban soil?

A) *Celtis occidentalis*
Hackberry

B) *Fraxinus americana*
White ash

Right species for the right site

Quercus alba


Ginkgo biloba


Metasequoia

Prevent and protect

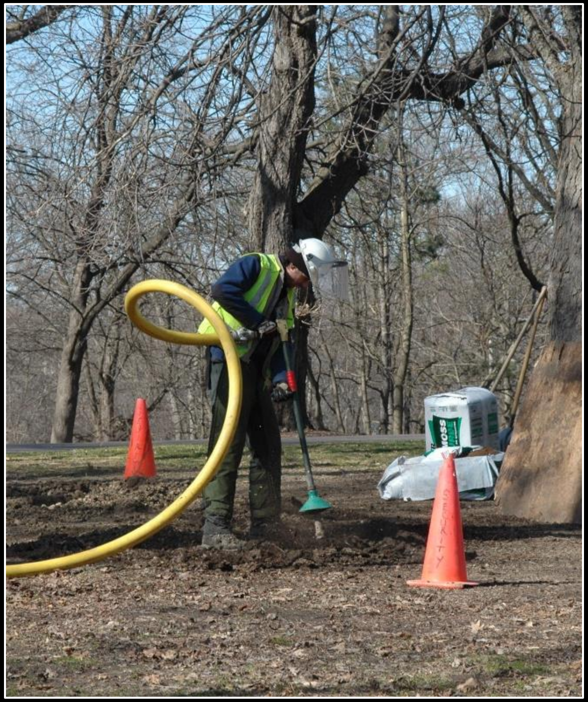
Compaction on wet soil in Glen Ellyn, IL

Prevent and protect

Tree "protection" in Glen Ellyn, IL

Tillage

Tillage

Radial trenching, drilling, and high-pressure air tillage

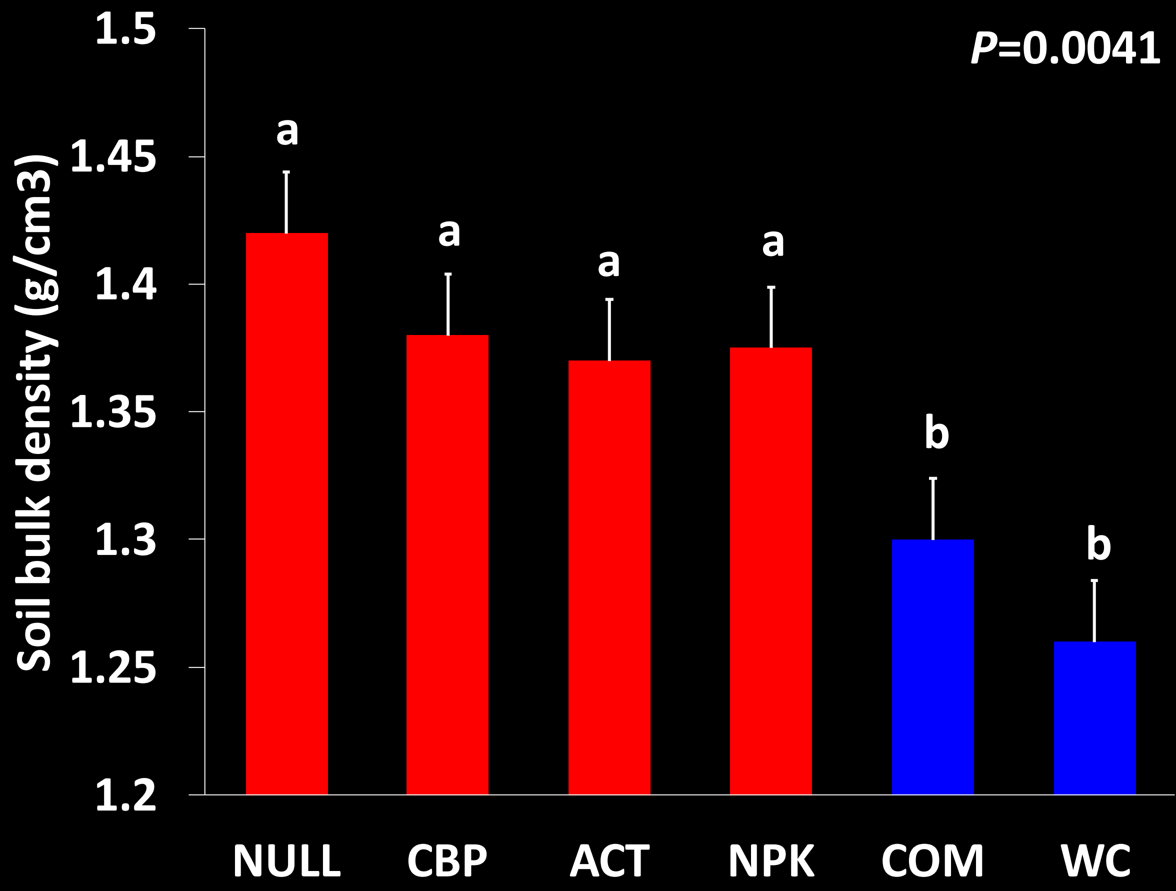
Tillage

Type	Effect on soil bulk density ($g\ cm^{-3}$)	References
Surface tillage	Minimal, short-lived	Patterson and Bates, 1994; Randrup, 1998
Trenching	None outside of trench	Watson, 1990; Day, 1993
Deep-jetting	Mixed, short-lived	Smiley et al., 1990; Rolf 1992; Smiley, 2001
Sub-soiling	Minimal, short-lived	Johnson et al., 1987; Rolf, 1998

Organic amendments

Scrape, compact, and fill disturbance followed by mulching
with compost and wood chips at The Morton Arboretum

Organic amendments



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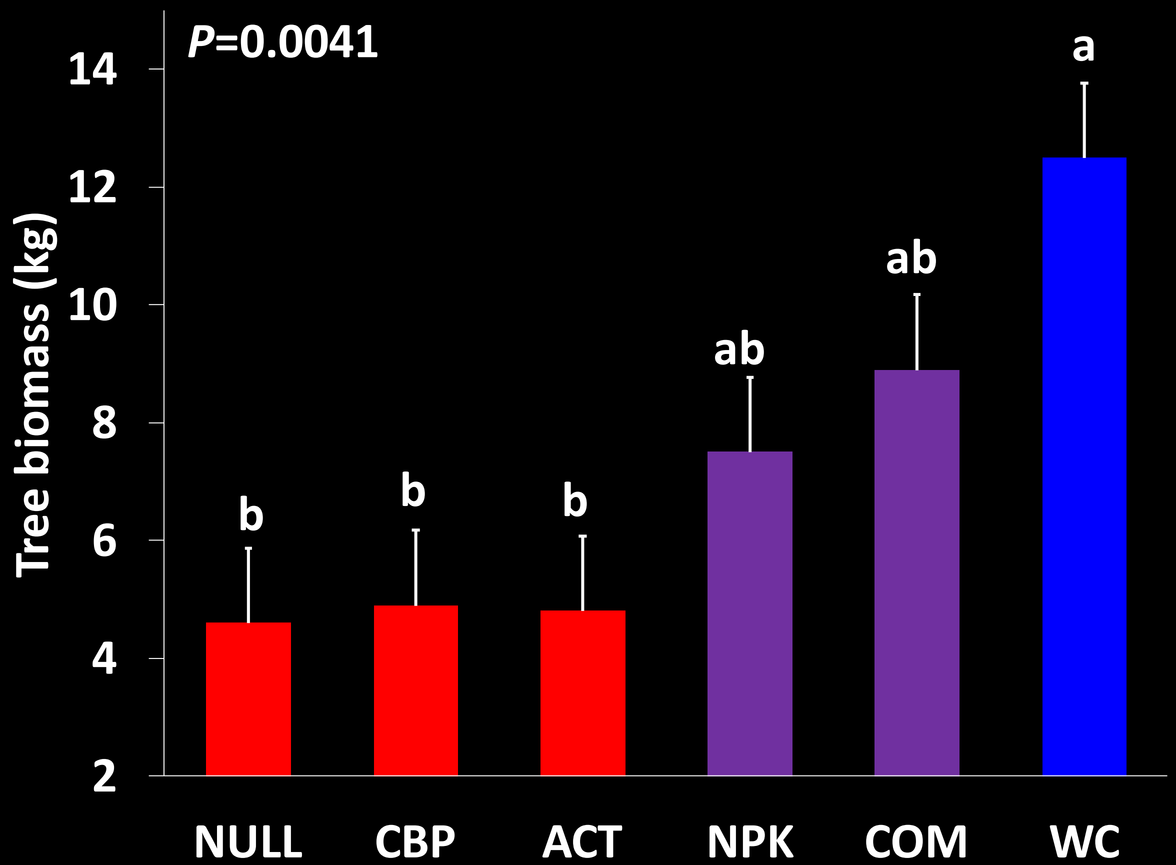
Organic amendments

Subangular and granular with compost and blocky and massive structure without

Organic amendments



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Organic amendments + tillage

Air tillage and organic matter amendment

Organic amendments + tillage

Type	Effect on soil bulk density ($g\ cm^{-3}$)	References
Organic mulches and amendments	-0.15 to -0.35	Scharenbroch et al., 2013; Scharenbroch and Watson, 2014
Organic with air tillage	-0.1 to -0.6	Scharenbroch et al. 2020 (in review)
Organic with subsoiling	-0.2 to -0.6	Chen et al., 2014; Layman et al., 2016

Compaction BMPs

- **Webinar on urban soil compaction (Scharenbroch, TREE Fund)**
  - https://www.youtube.com/watch?v=Plln8W1LyfQ&feature=youtu.be
- **Public informational video on compaction (UWSP students)**
  - https://www.youtube.com/watch?v=wIEn0_dzjPY&feature=youtu.be

Water – too wet

- Soil management for urban trees Part 1: Assessment
  - Why are some urban soils saturated?
  - What are the consequences of urban soil saturation?
- **What can we do about urban soils that are too wet?**

Water BMPs

What can we do about urban soils that are too wet?

- **Right species for the right site**
- **Reduce irrigation**
- **Improve infiltration and conductivity**
- **Divert surface water**
- **Drain subsurface water**

Right species for the right site

Q3: Which tree would you plant in a poorly drained urban soil?

A) ***Pinus nigra***
Austrian pine

B) ***Betula nigra***
River birch

Right species for the right site

Rain garden in Washington DC (US EPA)

Right species for the right site

Meadow Lake (retention pond) at The Morton Arboretum in Lisle, IL

Reduce irrigation

Anaerobic urban soil due to broken sprinkler head on the U. Idaho campus in Moscow, ID

Improve infiltration/conductivity

Massive and granular soil structure

Divert surface water

Anthropogenic drumlins at Three Bridges Park in Milwaukee, WI

Drain subsurface water

French drain

Poorly drained soil in an urban tree pit at Millennium Park in Chicago, IL

Water – too dry

- Soil management for urban trees Part 1: Assessment
  - Why are some urban soils too dry?
  - What are the consequences of dry urban soils?
- **What can we do about urban soils that are too dry?**

Water BMPs

What can we do about urban soils that are too dry?

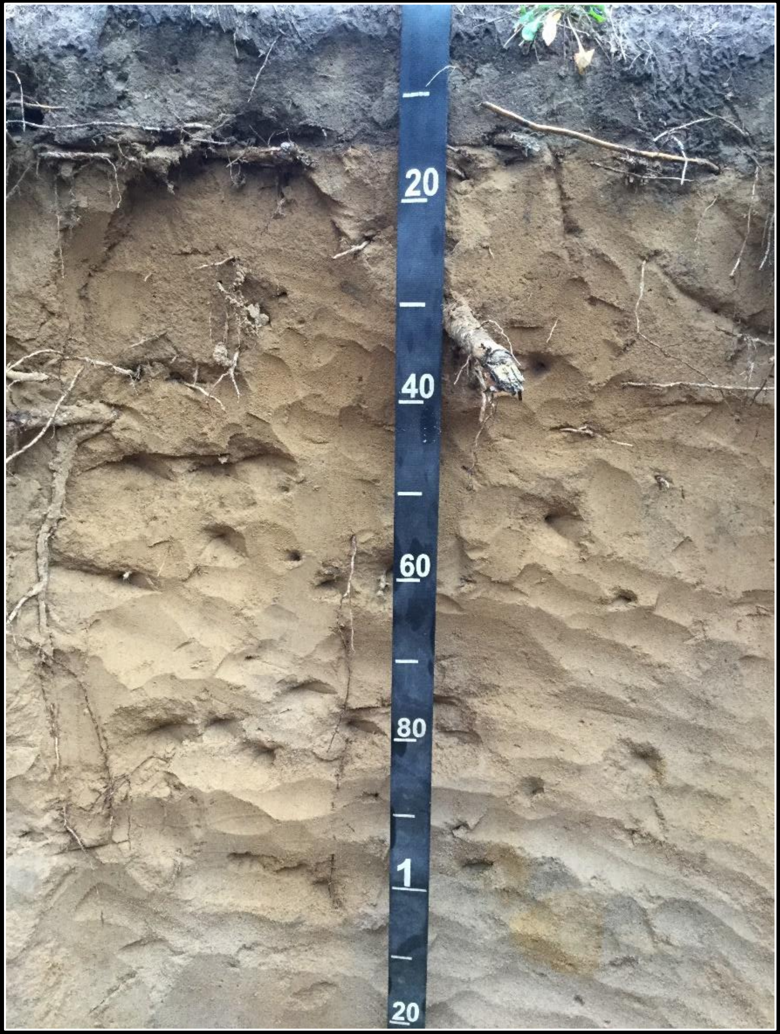
- **<u>Right species for the right site</u>**
- **Increase permeable surfaces**
- **Use mulch**
- **Amendments**
- ***Prescription* irrigation**

Right species for the right site

Q4: Which tree would you plant in a dry urban soil?

A) *Taxodium distichum*
Bald cypress

B) *Ginkgo biloba*
Ginkgo



Right species for the right site

Mesquite trees growing in Phoenix urban forest (Arizona State University)

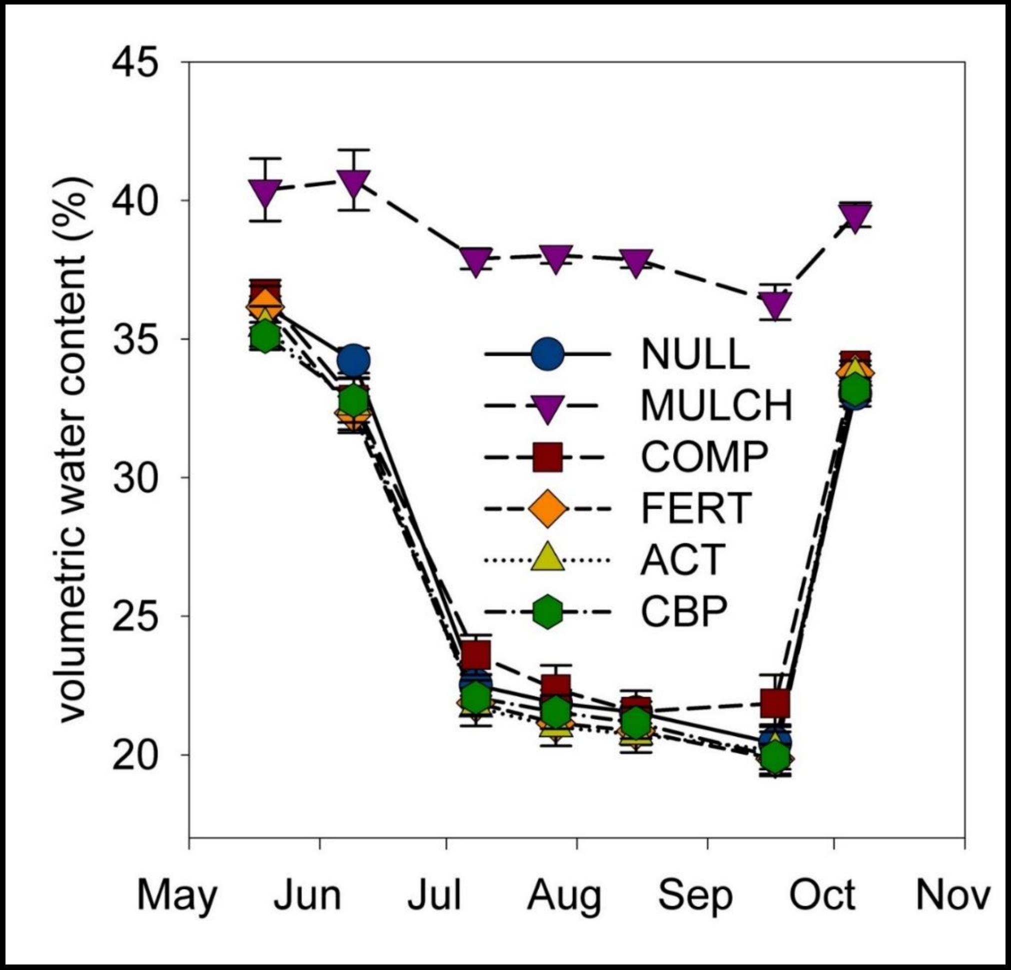
Increase permeable surfaces

Permeable paver and bioswale parking lot at The Morton Arboretum in Lisle, IL

Use mulch

Wood chip mulch at The Morton Arboretum

Use mulch



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Amendments

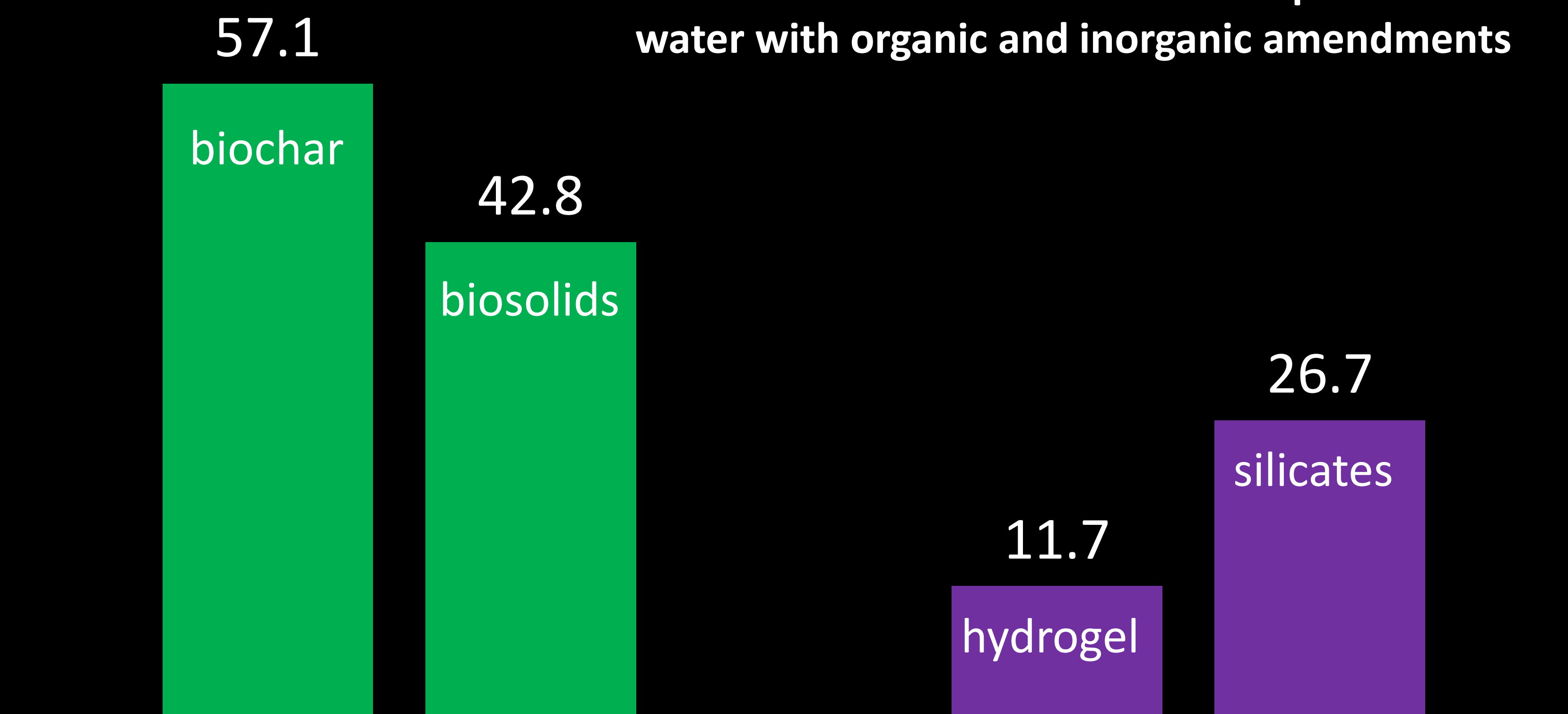
Biochar and biosolids

Amendments

Hydrogel and silicates

Amendments

Percent increase relative to control in plant available water with organic and inorganic amendments



Sax, M. S., & Scharenbroch, B. C. (2017). Assessing Alternative Organic Amendments as Horticultural Substrates for Growing Trees in Containers. *Journal of Environmental Horticulture*, *35*(2), 66-78.

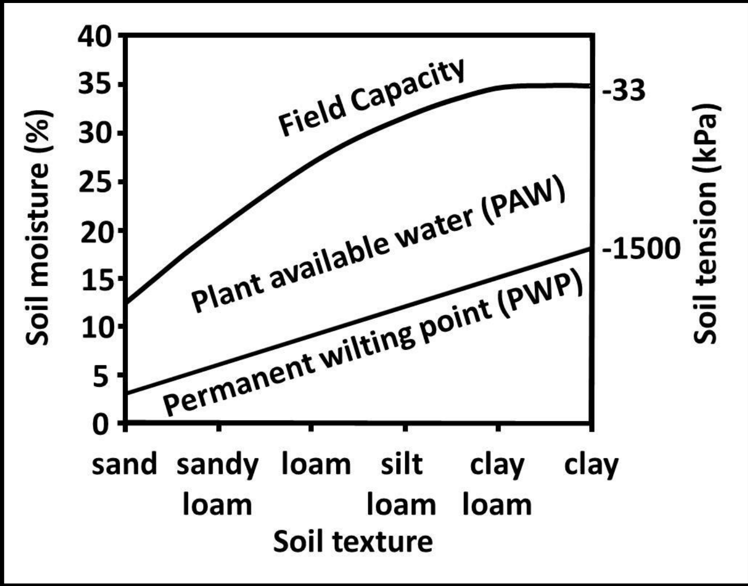
Farrell, C., Ang, X. Q., & Rayner, J. P. (2013). Water-retention additives increase plant available water in green roof substrates. Ecological Engineering, 52, 112-118.

Prescription irrigation

Sprinklers and tree gator bags in Glen Ellyn, IL

Prescription irrigation

- **How many days until irrigation is required?**
  - Supply
    - 25 cm deep Sandy loam soil with 20% rocks
    - $250\ mm_s * 0.125\ mm_w/mm_s\ 0.8 = 25\ mm_w$



Plant available water by soil texture

Prescription irrigation

- **How many days until irrigation is required?**
  - Demand (assumptions)
    - Bald cypress $\approx 10\ mm_w/d$
    - Ginkgo $\approx 5\ mm_w/d$

Taxodium distichum
Bald cypress

Ginkgo biloba
Ginkgo

Prescription irrigation

- **How many days until irrigation is required?**
  - Supply / demand = days until dry
    - Bald cypress = 25 mm_w / 10 mm_w/d = **2.5 d**
    - Ginkgo = 25 mm_w / 5 mm_w/d = **5 d**

Fertility

- **Soil management for urban trees Part 1: Assessment**
  - Why might urban soils have low fertility?
  - What are the consequences of low fertility in urban soils?
- **How do we manage soil fertility for urban trees?**

Fertility BMPs

How should we manage fertility in urban soils?

- **<u>Right species for the right site</u>**
- ***Prescription* fertilization**
  - Inorganic fertilizers
  - Organic amendments

Right species for the right site

Q5: Which tree would you plant in an infertile urban soil?

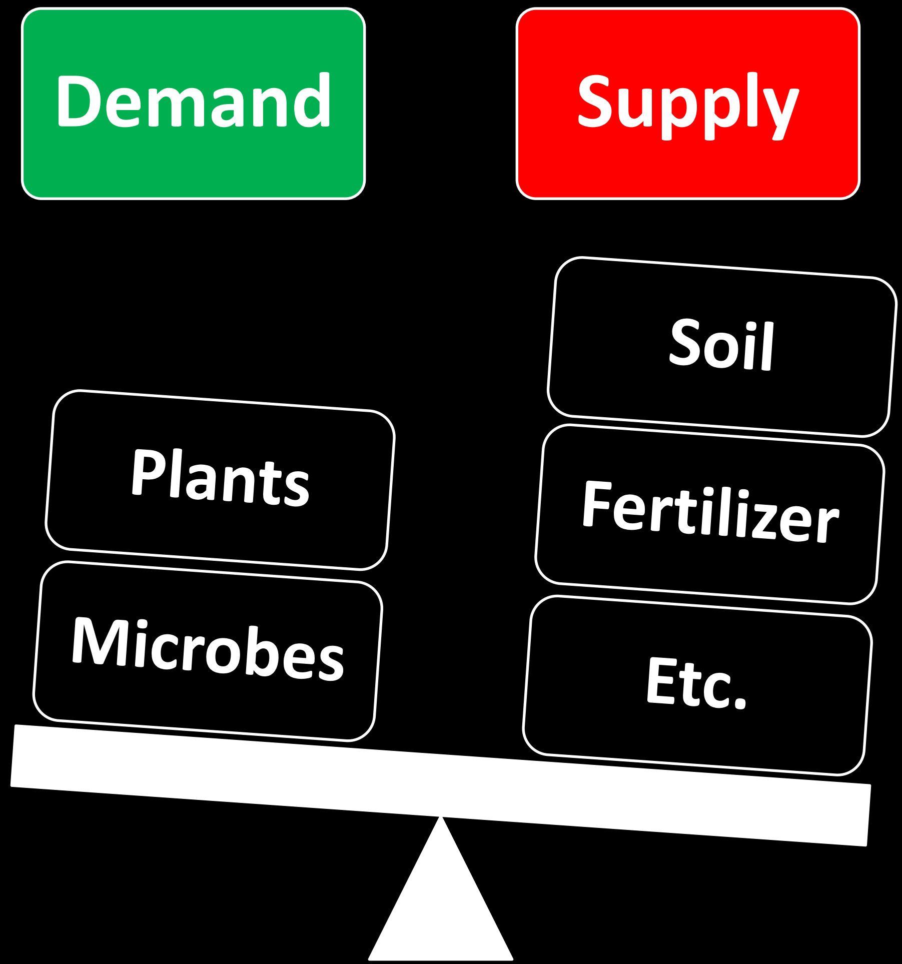
A) ***Tilia americana***
Basswood

B) ***Pinus resinosa***
Red pine

Prescription fertilization

Inorganic fertilizer, organic commercially available fertilizer, and non-commercial organic

Prescription fertilization



Prescription fertilization

- **What is the supply?**
  - How much available N is in this urban garden?
    - 100 m^2 by 25 cm deep
    - SCL with bulk density of 1.7 g cm^{-3}
    - 0.5% total N content (measured)
    - 10% of total N is mineralized each year (assumed)

$$\frac{\mathbf{1.7\ g}}{\mathbf{cm3}} \times \mathbf{1,000,000\ cm2} \times \mathbf{25\ cm} \times \frac{\mathbf{0.005\ kg\ N}}{\mathbf{kg\ soil}} \times \frac{\mathbf{0.1\ kg\ available\ N}}{\mathbf{kg\ N}}$$

ANSWER = 21.25 kg available N

Prescription fertilization

- **What is the demand?**
  - Trees (ANSI A300 standards)
    - 1-3 kg N 100 m^{-2} (2-6 lbs N 1000 ft^{-2})

Prescription fertilization

- **Is fertilization necessary?**
  - Assuming a plant demand of 1 kg N 100 m^{-2}, what soil N test levels would merit a N fertilizer in this garden?
    - 0.5% total soil N = 21.25 kg available N
    - __?__% total soil N = 1 kg available N

$$\frac{\textbf{0.5\% total N}}{\textbf{21.25 kg available N}} = \frac{\textbf{? \% total N}}{\textbf{1 kg available N}}$$

ANSWER = 0.024% total N

Prescription fertilization

- **Supply < demand**
  - How much <u>inorganic</u> fertilizer for a 1 kg N 100 m^{-2} deficiency?
    - 30-5-10 (N-P_2O_5-K_2O) and each bag is 22.7 kg (50 lb)

$$\frac{\mathbf{1\ kg\ N}}{\mathbf{100\ m2}} \times \frac{\mathbf{1\ kg\ fertilizer}}{\mathbf{0.3\ kg\ N}} \times \frac{\mathbf{1\ bag\ fertilizer}}{\mathbf{22.7\ kg\ fertilizer}}$$

ANSWER = 0.15 bags of fertilizer

Prescription fertilization

- **How much P have we added?**
  - Inorganic fertilizer: 0.15 bag fertilizer
    - 30-5-10 (N-P_2O_5-K_2O) and each bag is 22.7 kg (50 lb)

$$0.15 \text{ bag fertilizer} \times \frac{22.7 \text{ kg fertilizer}}{1\ bag\ fertilizer} \times \frac{0.05 \text{ kg } P_2O_5}{1 \text{ kg fertilizer}} \times \frac{0.437 \text{ kg P}}{1 \text{ kg } P_2O_5}$$

ANSWER: 0.07 kg P 100 m^{-2}

PLANT DEMAND: 0.2 kg P 100 m^{-2}

Prescription fertilization

- **Supply < demand**
  - How much organic fertilizer for a 1 kg N 100 m^{-2} deficiency?
    - Wet compost has 1.5% total N (measured), 10% of total N is available N (assumed), and 40% water (measured)

STEP 1: $$1 \text{ kg wet compost} \times \frac{0.6 \text{ kg dry compost}}{1 \text{ kg wet compost}} \times \frac{0.015 \text{ kg total N}}{1 \text{ kg dry compost}} \times \frac{0.1 \text{ kg available N}}{1 \text{ kg total N}} = \frac{0.0009 \text{ kg available N}}{1 \text{ kg wet compost}}$$

STEP 2: $$\frac{0.0009 \text{ kg available N}}{1 \text{ kg wet compost}} = \frac{1 \text{ kg available N}}{? \text{ kg wet compost}}$$

ANSWER = 1,111 kg of wet compost

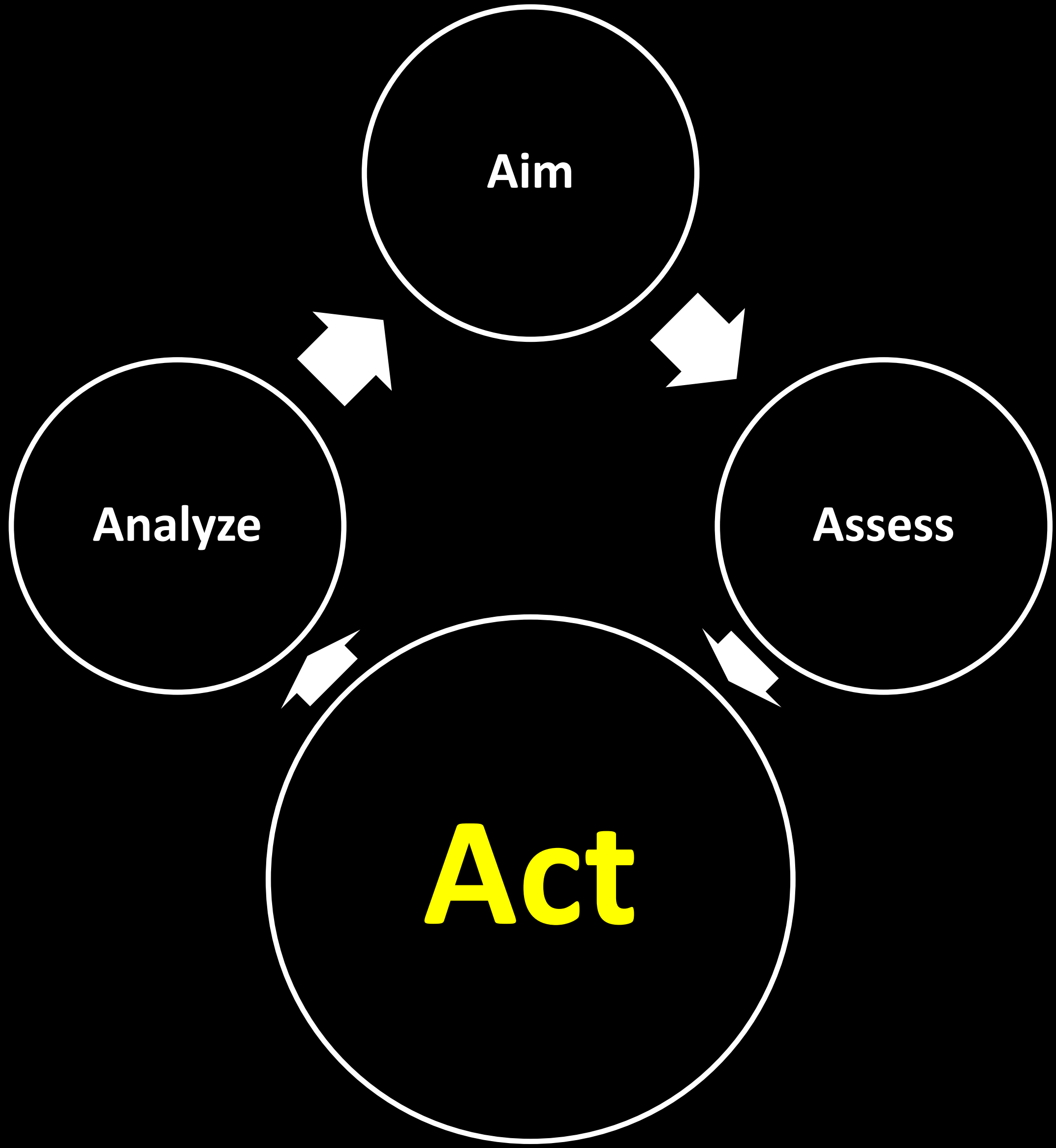
Prescription fertilization

- **How much P have we added?**
  - <u>Organic</u> fertilizer: 1,111 kg of wet compost
    - Wet compost has 1% total P (measured), 10% of total P is available P (assumed), and 40% water (measured)

$$1{,}111 \text{ kg wet compost} \times \frac{0.6 \text{ kg dry compost}}{1 \text{ kg wet compost}} \times \frac{0.01 \text{ kg total P}}{1 \text{ kg dry compost}} \times \frac{0.1 \text{ kg available P}}{1 \text{ kg total P}}$$

ANSWER: 0.67 kg P 100 m^{-2}

PLANT DEMAND: 0.2 kg P 100 m^{-2}



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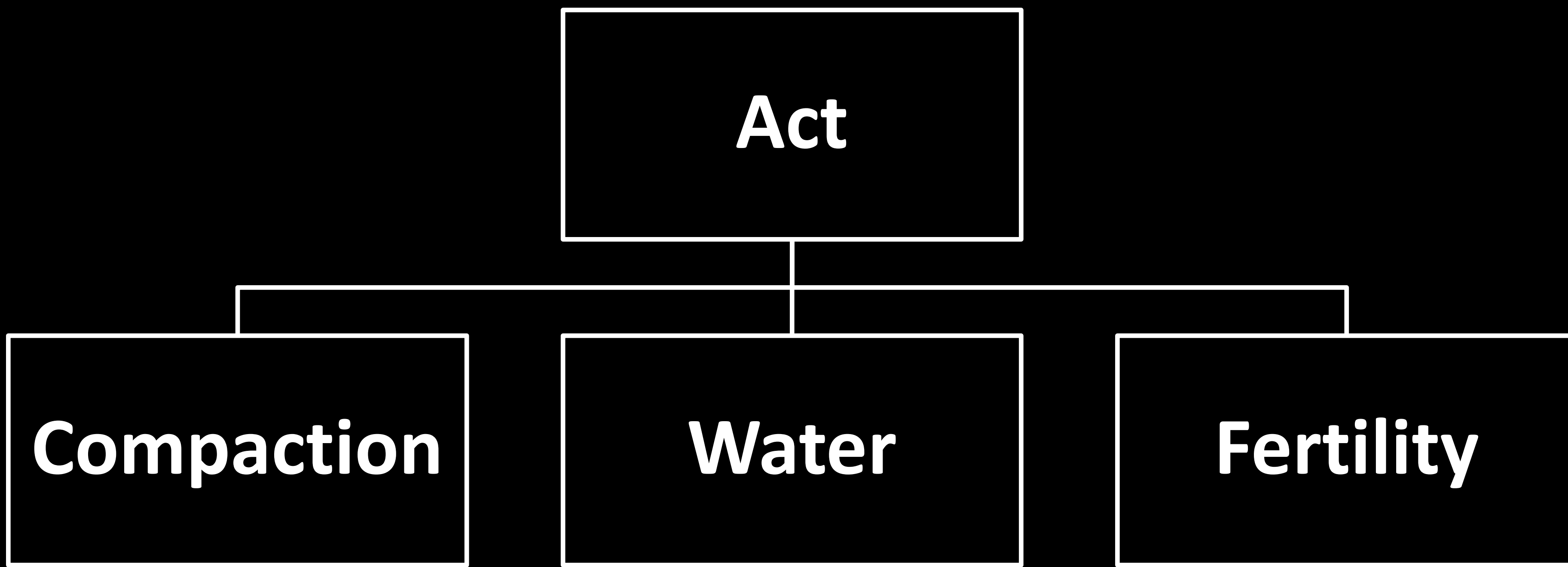

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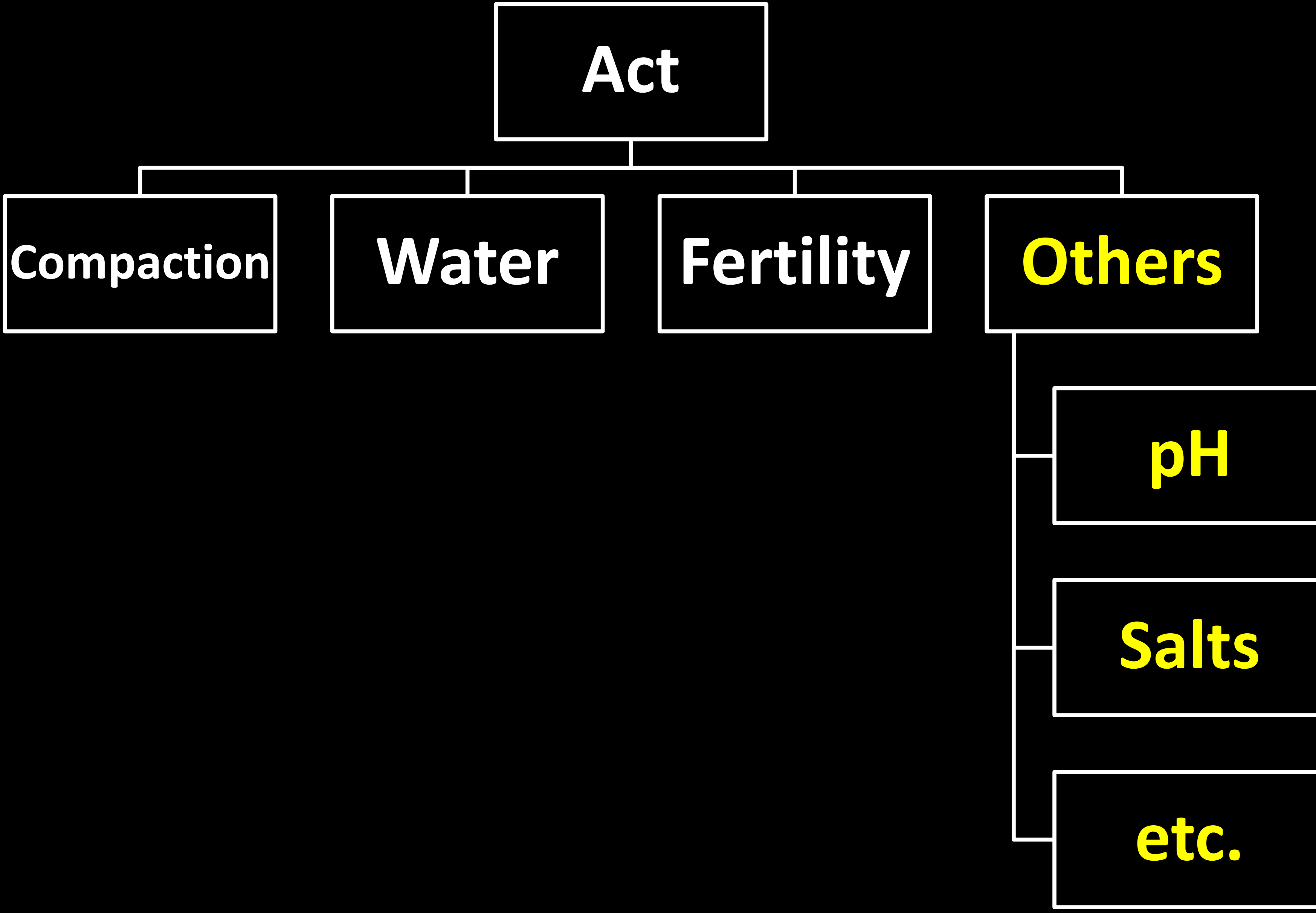

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Thank you

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