

Green Thumb Education Series:
“Diagnosing Environmental Stress”
will start momentarily.

Upcoming Master Gardener Events:

April 8: Garden Walk: Fifth Street Community Garden, 10-11:30

April 13: Garden Design: *Two Views, Old and New*
Bev Dawson and Marilyn Elliott, Master Gardeners
Location: Clallam County Courthouse Commissioners' Room

April 27: Pollinator Plantings: *Perfecting the Process*
Nita Wester, Jefferson County Master Gardener
Location: Carver Room, Port Angeles Public Library



WSU EXTENSION
Clallam County

Stressed Out!



How to recognize, treat, and avoid environmental stresses in trees and shrubs

Seminar overview

- 🍁 Symptoms of water stress
 - 🍁 Reduced leaf water
 - 🍁 Salt
 - 🍁 Hypoxia
- 🍁 Anthocyanins as a diagnostic tool
- 🍁 Diagnostic delusions!

Almost every stress is related to water



Leaf wilt



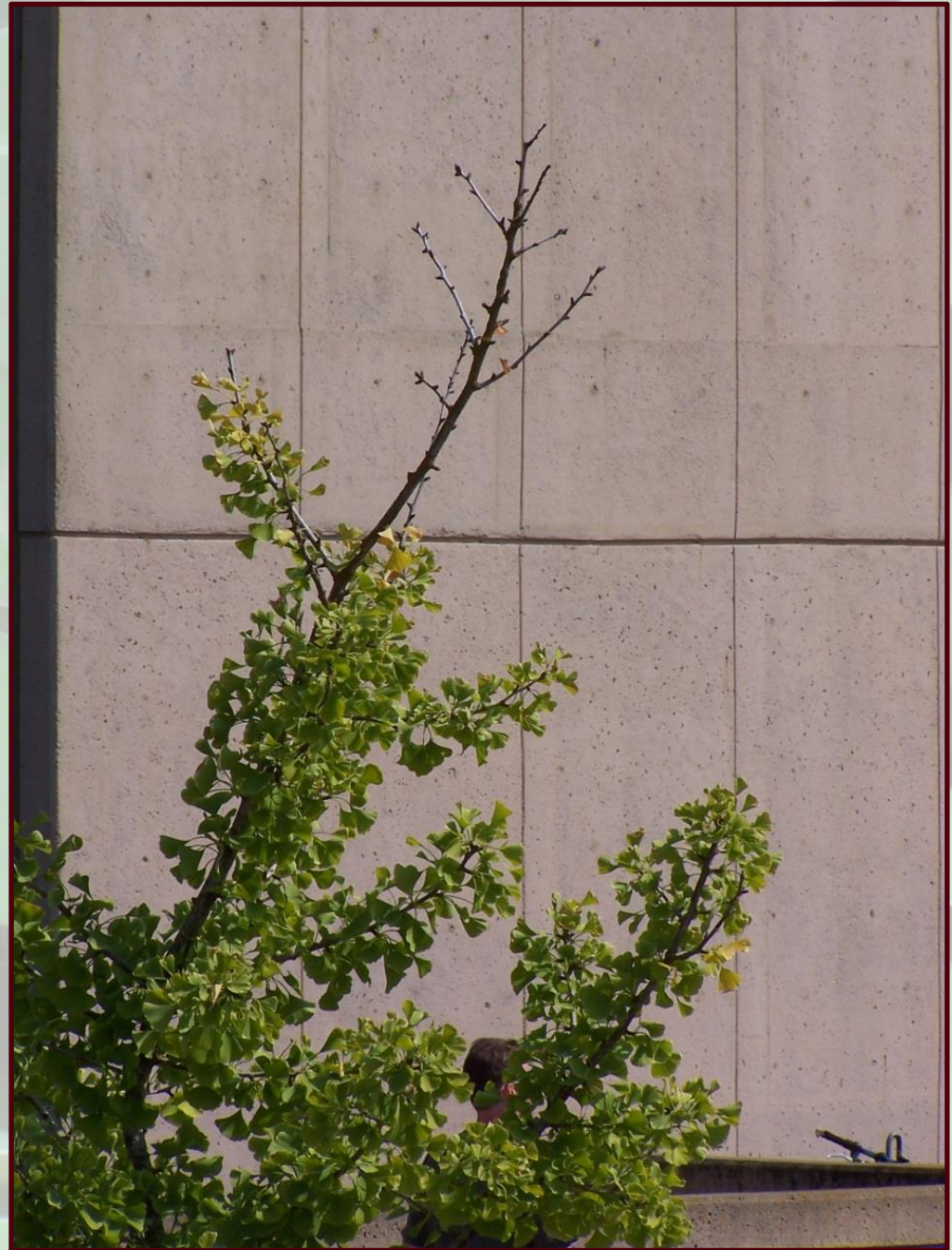
Tip and marginal reddening



Tip and marginal necrosis



Branch tip
dieback from
chronic, severe
drought



Decreased leaf size



Suckers and water sprouts



Early leaf color change (and drop)



Salinity stress symptoms

- 🍁 Wilting
- 🍁 Marginal and tip necrosis
- 🍁 Premature leaf drop
- 🍁 White salt crusts



Hypoxic soils

Compaction



Hypoxic soils



Flooded conditions

Soil hypoxia reduces leaf water

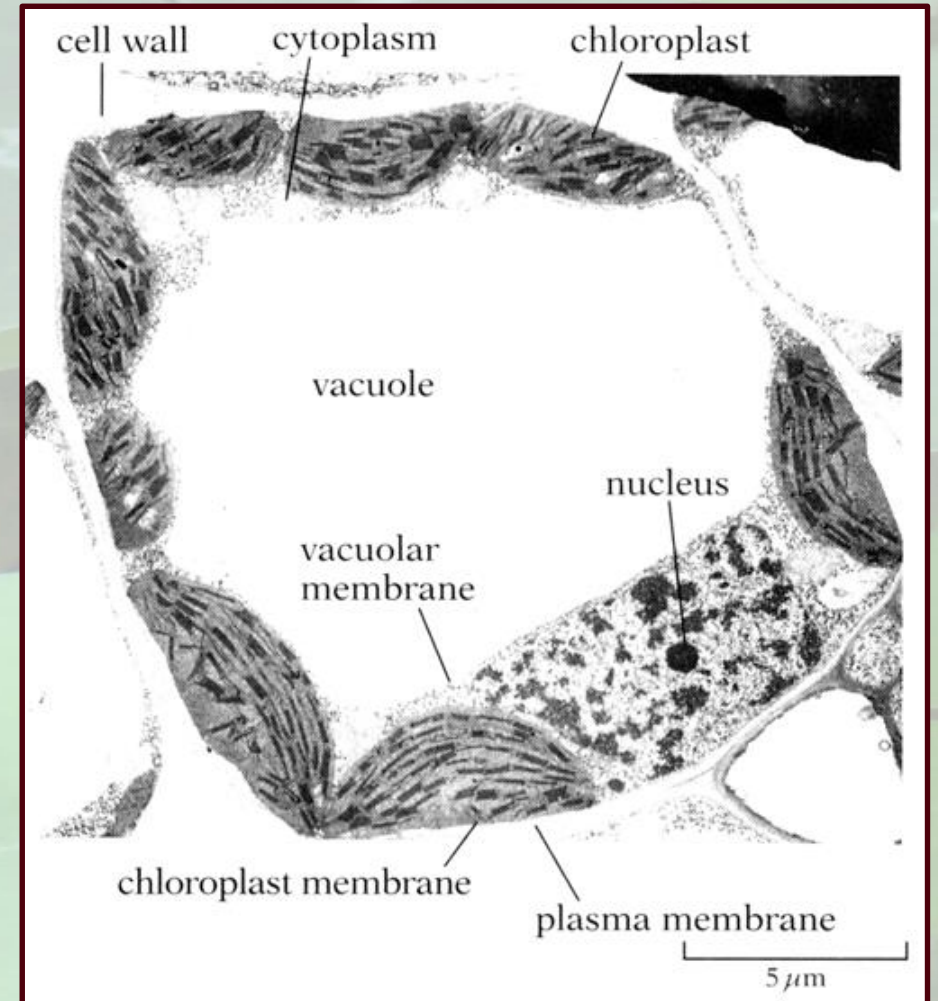
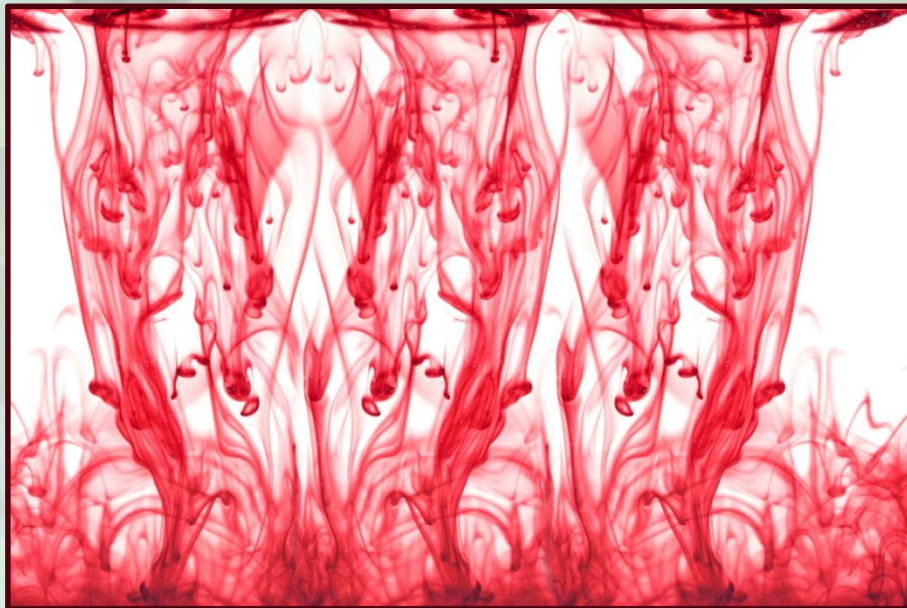
- 🍁 Pore space restricted by compaction or excess water
- 🍁 Oxygen reduced by lack of pore space or grade changes
- 🍁 Root function impaired
- 🍁 Leaves receive less water

Grade changes over root zone



Anthocyanins in diagnosis

- 🍁 Water soluble pigment
- 🍁 Found in vacuoles



Genetics



Young tissues

- 🍁 Lack of cuticle
- 🍁 Turgor maintenance

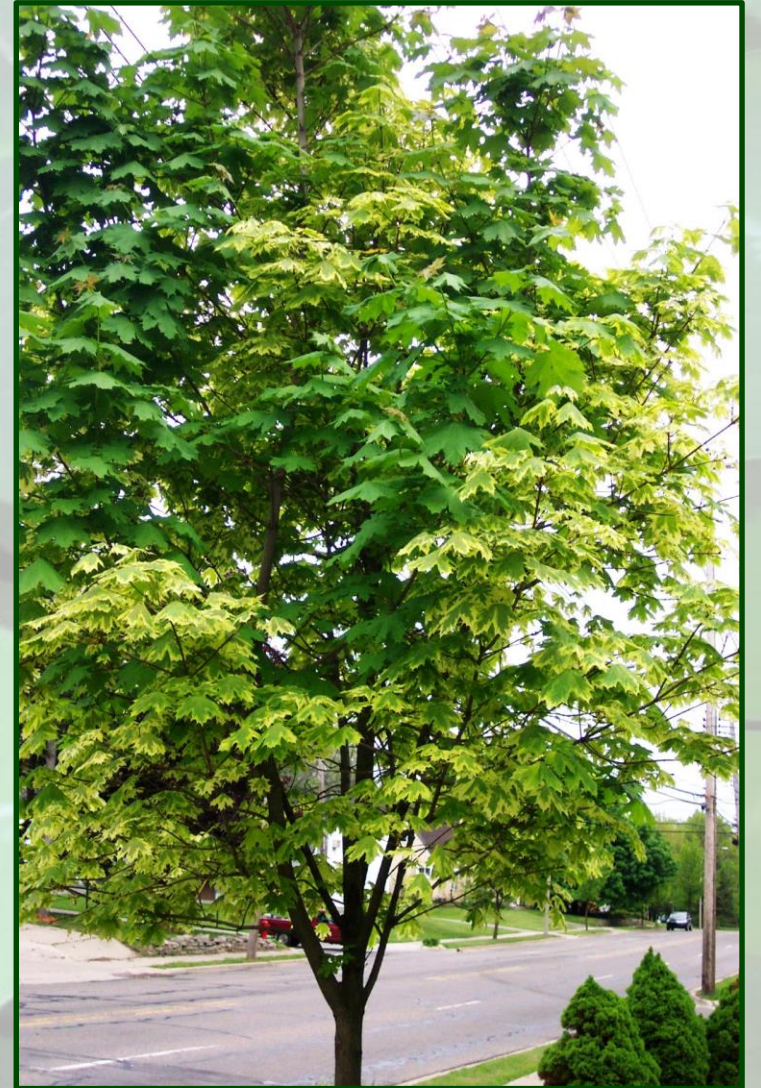


Environmental transience



- 🍁 Stress response
- 🍁 Normal color returns once stress is relieved (or leaves die)

Diagnostic Delusions: You can't always believe your eyes



Hereditary Hijinks



- 🔍 Cultivated variation in foliage
- 🔍 Reversion to wild type
- 🔍 Natural variation in bark
- 🔍 Morphological mutations

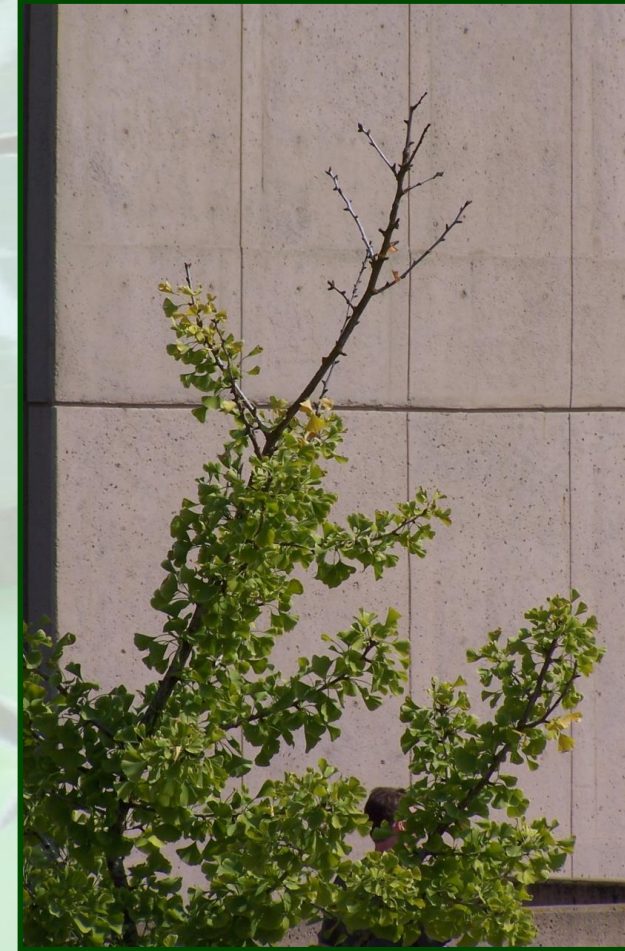


Weather wrongdoings



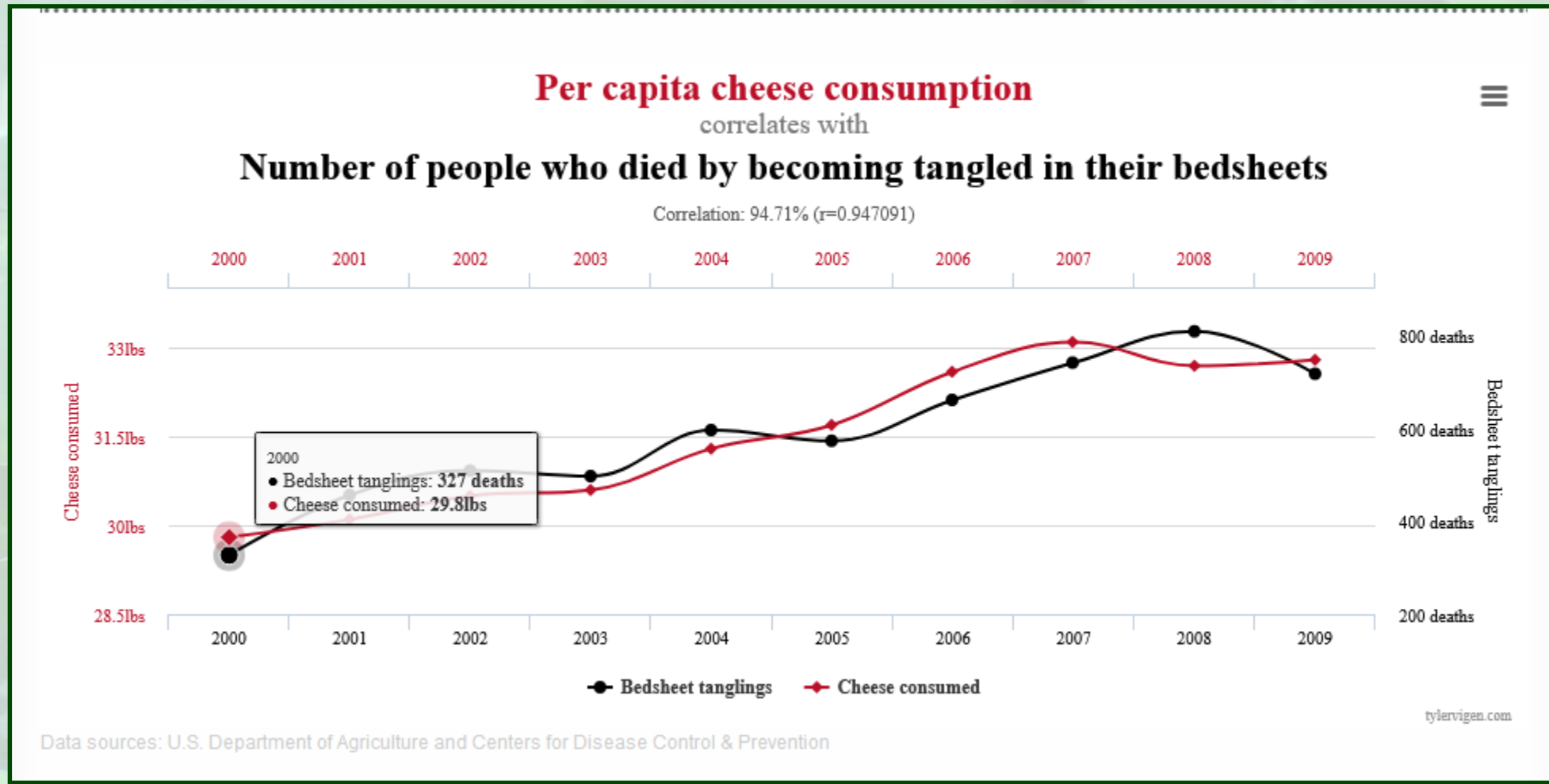
- 🔍 Late freezes
- 🔍 Heat during tissue expansion
- 🔍 Excessive heat or drought

Cultural Crimes and Management Malpractice



- 🔍 Poor quality plants
- 🔍 Poor siting and installation
- 🔍 Poor irrigation and fertilizer use

Avoid equating correlation with causation!



<https://www.tylervigen.com/spurious-correlations>

Case Study #1: Nutrient deficiencies



“Leaf chlorosis is a good indicator for adding nutrients”



“Crime” lab analysis

<i>Analysis</i>	<i>Value Found</i>	<i>Optimum Range</i>	<i>Analysis</i>	<i>Value Found</i>	<i>Optimum Range</i>
Soil pH (1:1, H ₂ O)	6.7		Cation Exch. Capacity, meq/100g	19.3	
Modified Morgan extractable, ppm			Exch. Acidity, meq/100g	3.7	
<i>Macronutrients</i>			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		
<i>Micronutrients</i> *			Soil Organic Matter (LOI), %	8.7	
Boron	0.4	0.1-0.5	Nitrate-N (NO ₃ -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			



- 🔍 Excess soil nutrients can cause leaf deficiencies
- 🔍 Many fertilizers are high in P
- 🔍 Excess P reduces root uptake of Fe, Mn

Let tests guide nutrient additions

Results

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Soil pH (1:1, H ₂ O)	6.7		Cation Exch. Capacity, meq/100g	19.3	
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* 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!!!

Results

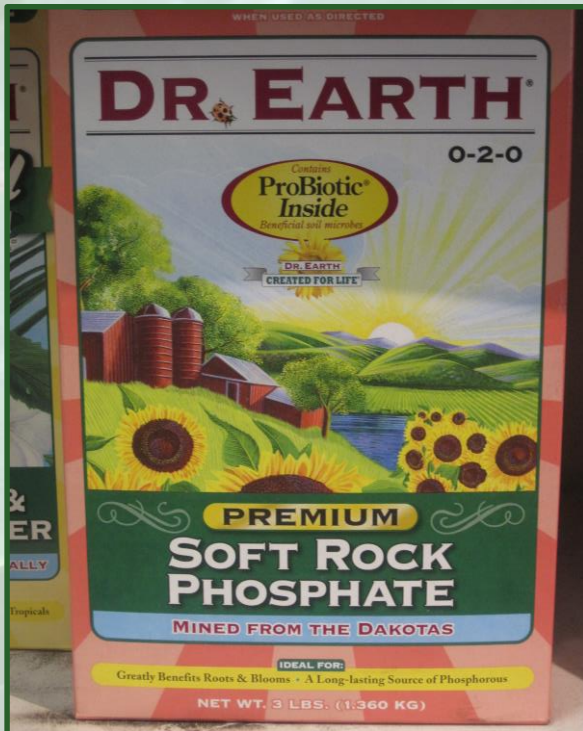
Analysis	Value Found	Optimum Range	Analysis	Value Found	Optimum Range
Soil pH (1:1, H ₂ O)	4.9		Cation Exch. Capacity, meq/100g	20.4	
Modified Morgan extractable, ppm			Exch. Acidity, meq/100g	12.6	
Macronutrients			Base Saturation, %		
Phosphorus (P)	3.4	4-14	Calcium Base Saturation	32	50-80
Potassium (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		
Sulfur (S)	20.8	>10		1.03	
Micronutrients *			Optional tests		
Boron (B)	0.3	0.1-0.5	Soil Organic Matter (LOI), %	12.8	
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			

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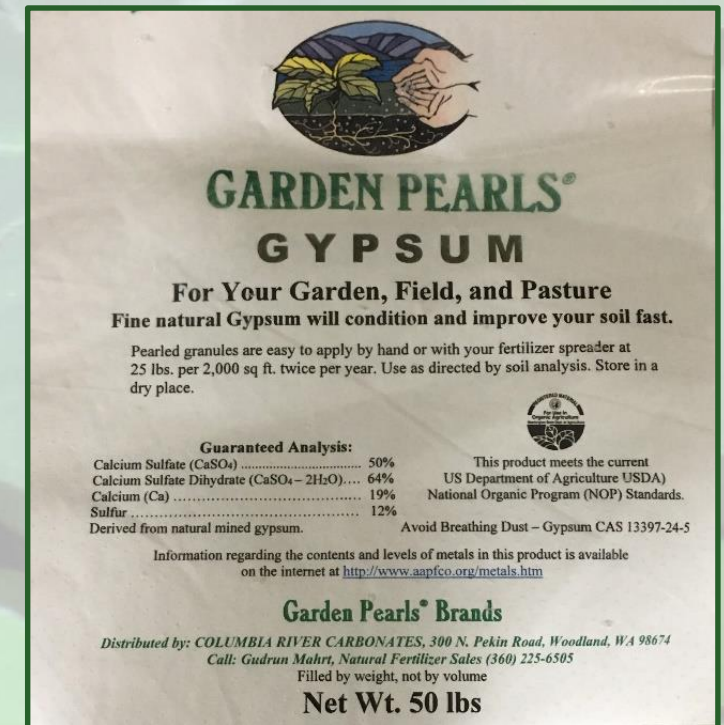
Commonly excessive nutrients



Phosphate



Magnesium



Calcium

Peer-reviewed information

Iron Deficiency in *Rhododendron* is Due to Excess Soil Phosphorus

Linda Chalker-Scott and Scott S. Olmsted

Commercial "transplant" fertilizers are generally phosphate-rich, potentially resulting in nutrient overload in nonagricultural urban soils. It is hypothesized that such fertilizers can result in reduced plant health because of nutrient imbalances. In this experiment, rhododendrons—a common landscape species—were grown under increasing levels of phosphate fertilizer in a greenhouse. Soil concentrations of available phosphate were elevated as a result of using high-phosphate fertilizers, inducing both root and foliar damage. While inappropriate use of high-phosphate fertilizers in urban landscapes will contribute to watershed pollution, this experiment demonstrates their harm on the root-soil environment as well.

Over the past two decades, there has been an increase in the amount of research examining chlorosis in ornamental plants in nursery production as well as in urban landscapes (Pataky 1996; Rose 1997; Krawczyk 2008). With over 250 species of plants susceptible to chlorosis, the causes of the disorder need continued research (Pataky 1996).

Rhododendron are ericaceous species that prefer moist, well-drained acidic soils (pH 5.0-6.5) with moderate to high amounts of organic matter. These common landscape ornamentals have high economic and aesthetic value for their striking floral displays. *Rhododendron*, with their shallow, fibrous root systems, are particularly sensitive to mineral imbalances, (Mason 2001) commonly exemplified by interveinal chlorosis of new leaves (Figure 1). Not only does this detract from the aesthetics of the plants, but it can also make them more susceptible to pests and diseases (Pataky 1996).

Iron Deficiency

The only nutrient deficiencies directly associated with interveinal chlorosis of new leaves are those of iron (Fe) and manganese (Mn); both are involved in the manufacture of chlorophyll. While Mn deficiency symptoms are somewhat similar to those of Fe, chlorosis caused by the latter occurs throughout the space between the veins (Figure 2). Furthermore, Mn deficiency symptoms are usually first



Figure 1. Chlorotic rhododendron.

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Photo Credit: Peter Corbett

EPSOM SALT USE IN HOME GARDENS AND LANDSCAPES

Linda Chalker-Scott, Associate Professor and Extension Horticulturist, WSU Puyallup Research and Extension Center, Washington State University; and Rich Guggenheim, Horticulture Extension Educator, Canyon County Extension, University of Idaho

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Photo Credit: James St. John

GYPSUM USE IN HOME GARDENS AND LANDSCAPES

Linda Chalker-Scott, Associate Professor and Extension Horticulturist, WSU Puyallup Research and Extension Center, Washington State University, and Rich Guggenheim, Horticulture Extension Educator, Canyon County Extension, University of Idaho

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FS307E

Low does not equal deficient

Results

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Sulfur (S)	20.8	>10	Optional tests		
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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			
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Potassium (K):				
Calcium (Ca):				
Magnesium (Mg):				

Ground-truthing

- 🔍 Evidence of deficiencies?
- 🔍 Plant symptoms?
- 🔍 Nutrient toxicities?



Results

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Case Study #2: Volcano mulching



“Deep layers of wood chips will kill trees”

Are you sure that volcano is just mulch?



Mulch can hide a variety of sins...



...like bad planting...

...and bad roots...



...and mulch gets the blame

Removing materials from root ball allows



barrier removal



root correction



planting at grade

Hand in glove stabilizes roots;
ball in socket does not



Coarse wood chips and bark wounds



- 🔍 Coarse wood chips caused faster wound sealing
- 🔍 No trees in volcanos developed disease or died

Arborist wood chips (AWC)



Coarse




Fine



- 🔍 Deep layers of coarse chips will suppress weeds and enhance tree roots and mycorrhizae
- 🔍 Fine mulches restrict air movement

Peer-reviewed publication


Soil & Tillage Research 194 (2019) 104335




Contents lists available at [ScienceDirect](#)

Soil & Tillage Research

journal homepage: www.elsevier.com/locate/still



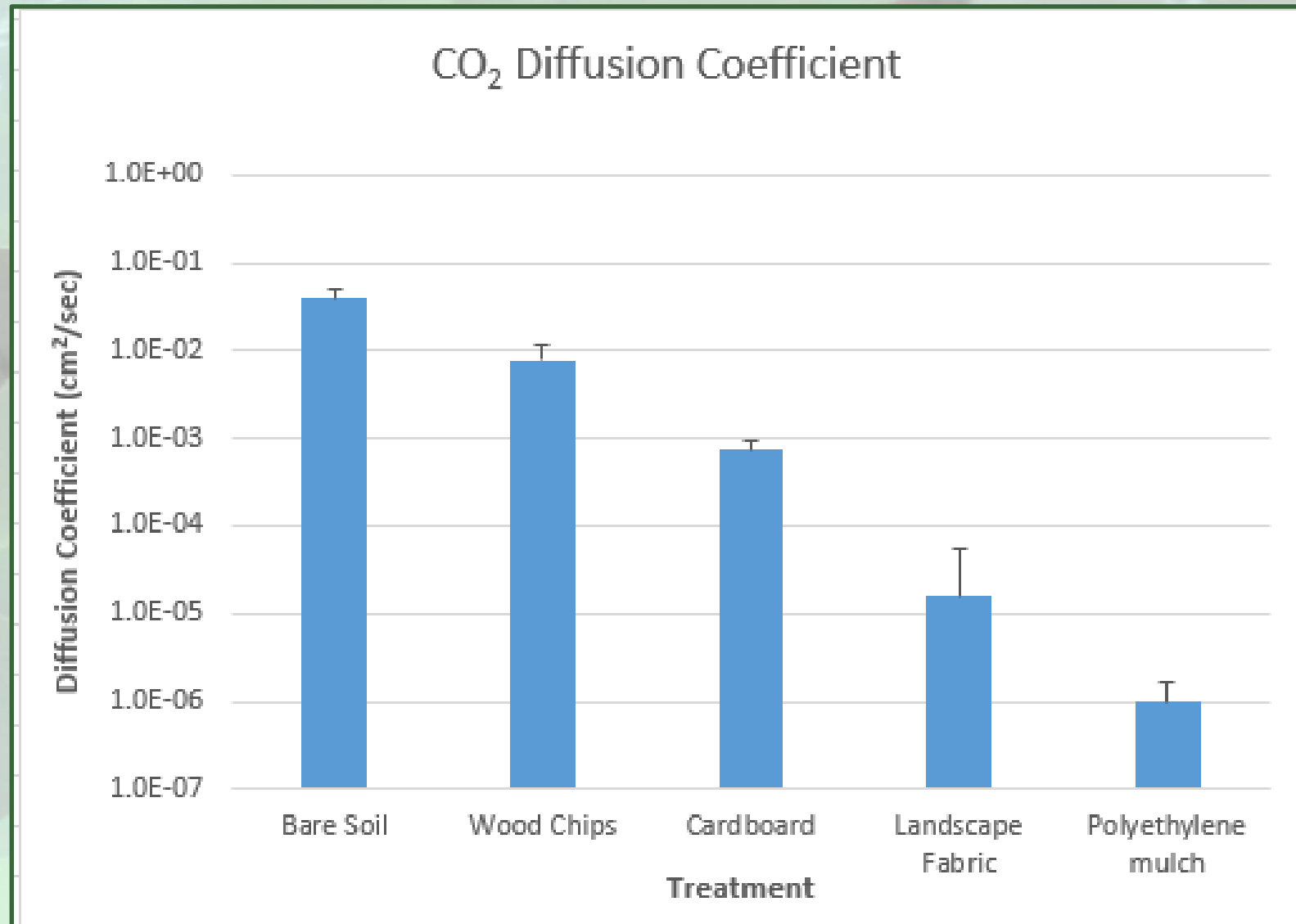
Carbon dioxide and oxygen exchange at the soil-atmosphere boundary as affected by various mulch materials 

Khurram Shahzad^{a,b,c}, Andy I. Bary^{a,b}, Douglas P. Collins^{a,b}, Linda Chalker-Scott^{b,d}, Muhammad Abid^c, Henry Y. Sintim^{a,b}, Markus Flury^{a,b,*}

^a Department of Crop & Soil Sciences, Washington State University, Pullman, WA 99164, USA
^b Puyallup Research & Extension Center, Washington State University, Puyallup, WA 98371, USA
^c Department of Soil Science, Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan, Pakistan
^d Department of Horticulture, Washington State University, Puyallup, WA 98371, USA

“Among the mulches tested, wood chips are a preferred method of mulching in terms of providing best gas permeability, particularly in landscape conditions.”

Graphic comparisons



The background of the image is a close-up, slightly out-of-focus photograph of green leaves. The leaves are rounded and have prominent veins, creating a textured, natural backdrop. A white rectangular box with a thin black border is centered in the upper half of the image, containing the text.

Science-based resources

Horticultural Myths



WASHINGTON STATE
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🔍 ✉️ ➦

- 🏠 Horticultural Myths
- The Informed Gardener
- Fact Sheets & Case Studies
- Landscape Rehab Projects
- Seminar Schedule
- Curriculum Vitae

Puyallup Research & Extension Center

Gardening in Washington State

The Garden Professors Blog



myWSU ACCESS POLICIES ©



LINDA CHALKER-SCOTT
Horticultural Myths

Horticultural Myths

Looking for the newest myth-information? Check out our blog [The Garden Professors](#). You'll find science-based information from four horticultural professors from around the country.

Fertilizers

- The Myth of Beneficial Bone Meal
- The Myth of Vitamin Shots
- The Myth of Foliar Feeding

Phosphate

- The Myth of Phosphate Fertilizer
- The Myth of Phosphate Part II

How Plants Work

- The Color Conundrum
- The Myth of Mineral Magic
- The Myth of Xeriscaping
- The Myth of Well-Behaved Ornamentals
- The Myth of Wilting Leaves
- The Myth of Night Light

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Add update

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Science-based information for gardens and landscapes

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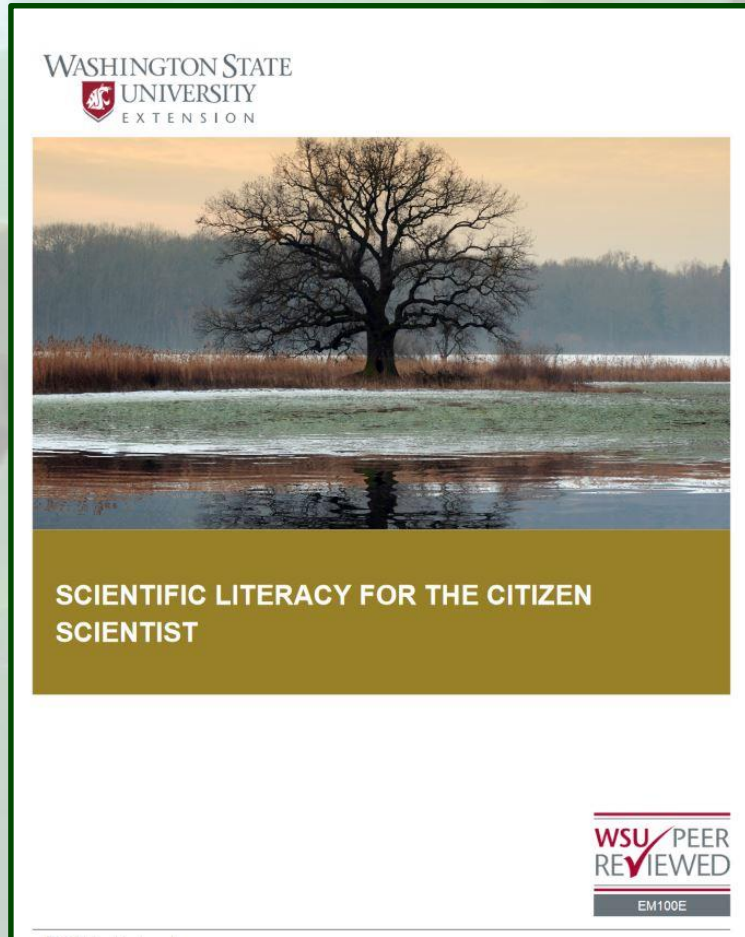
Add update

Plant stress physiology

Project

Add update

Scientific literacy manual



Free,
downloadable,
peer-reviewed
guide

NACAA Journal series



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JOURNAL OF THE NACAA

ISSN 2158-9429

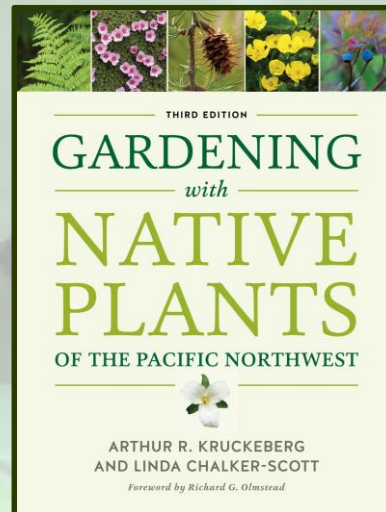
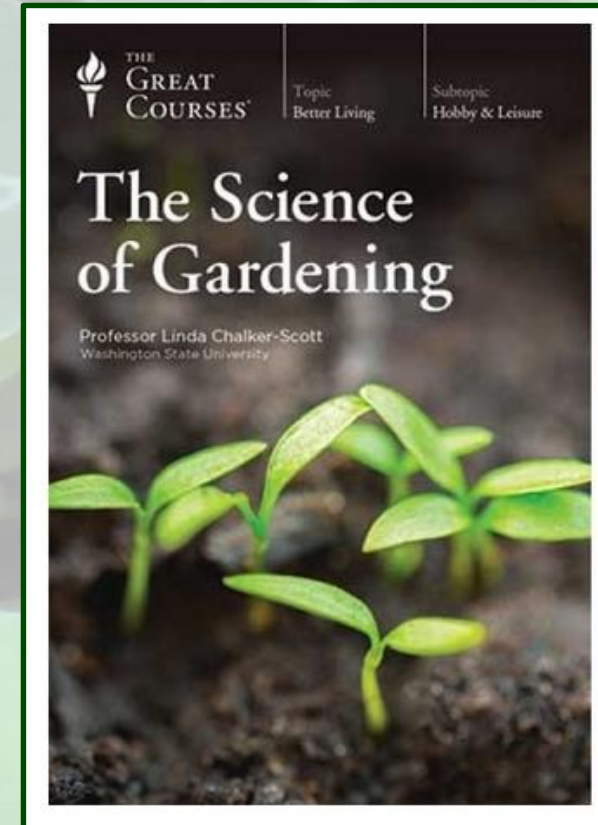
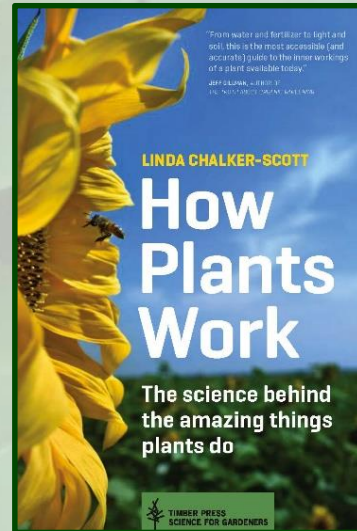
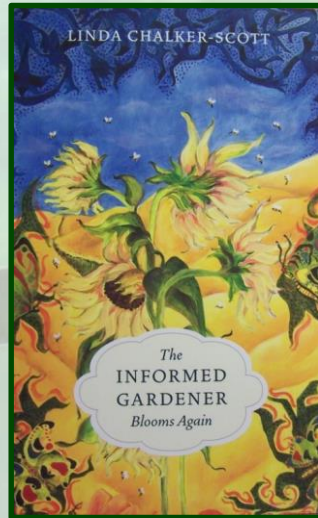
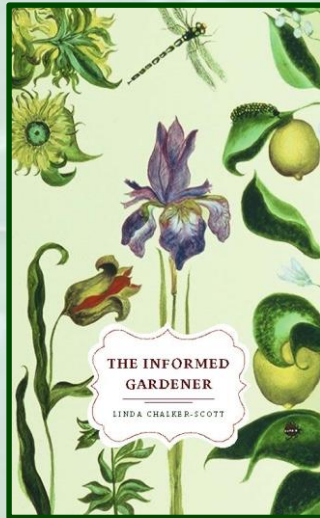
VOLUME 14, ISSUE 2 - DECEMBER, 2021

Editor: Donald A. Llewellyn

MYTH BUSTING FOR EXTENSION EDUCATORS: REVIEWING THE LITERATURE ON PRUNING WOODY PLANTS

Chalker-Scott, L., Extension Specialist And Professor, Washington State University
Downer, A.J., Farm Advisor, University of California

Science-based books and videos



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Garden Logic – understanding correlation and causation in our gardens and landscapes



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The Garden Professors blog



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The background of the image is a dense, close-up photograph of green leaves. The leaves are mostly rounded or oval-shaped with a prominent central vein and several lateral veins branching out. They are a vibrant green color, with some areas showing slight variations in shade or texture. The leaves are arranged in a way that they overlap, creating a layered effect. In the center of the image, there is a white rectangular box with a thin black border. Inside this box, the word "Questions?" is written in a large, bold, green serif font.

Questions?