Tree Health Issues

Abiotic Tree Problems, Tree Diseases, & Stress Factors

Master Gardener Tree Care Specialist Training

March 14, 2019

Garland, TX

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TEXAS A&M AGRILIFE RESEARCH | EXTENSION

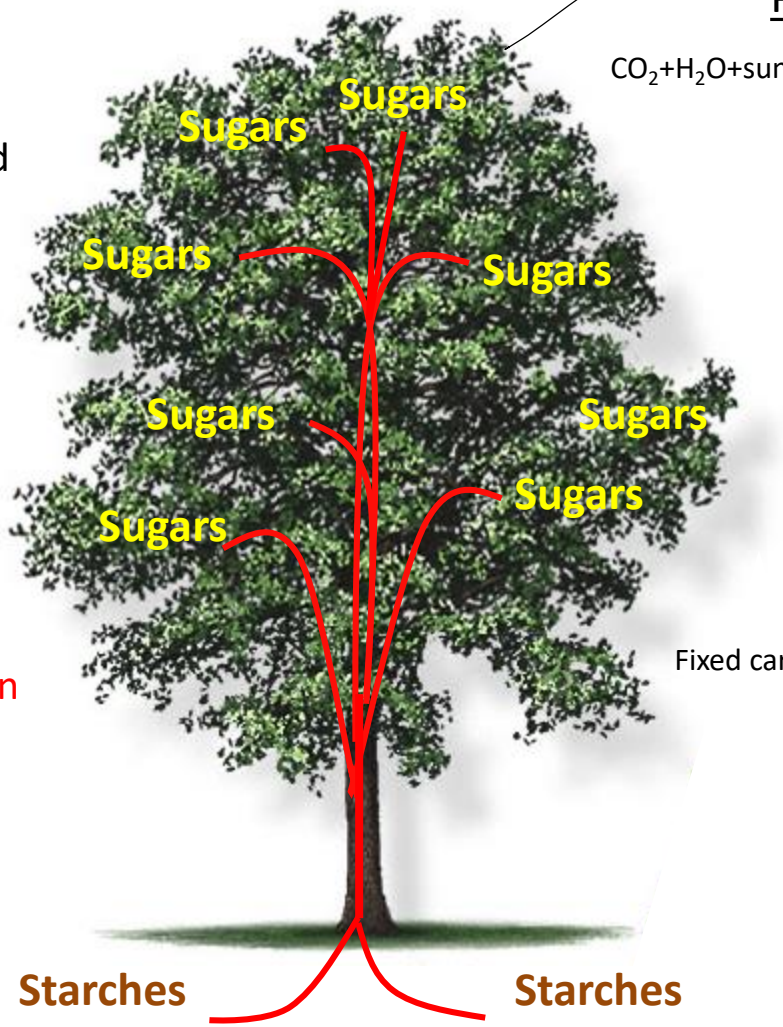
Presentation Outline

- Attributes of a healthy tree,
- What can go wrong?
- The threat of drought to good tree health,
- Tree diseases associated with Declines,
- Diseases of non-stressed trees,

I. Tree Physiology and Resource Allocation

Resources, in the form of sugars and starches, needed for growth, reproduction, and host defense.

Water is a building material in photosynthesis, a reaction medium for cell chemistry and a transport medium.



Photosynthesis

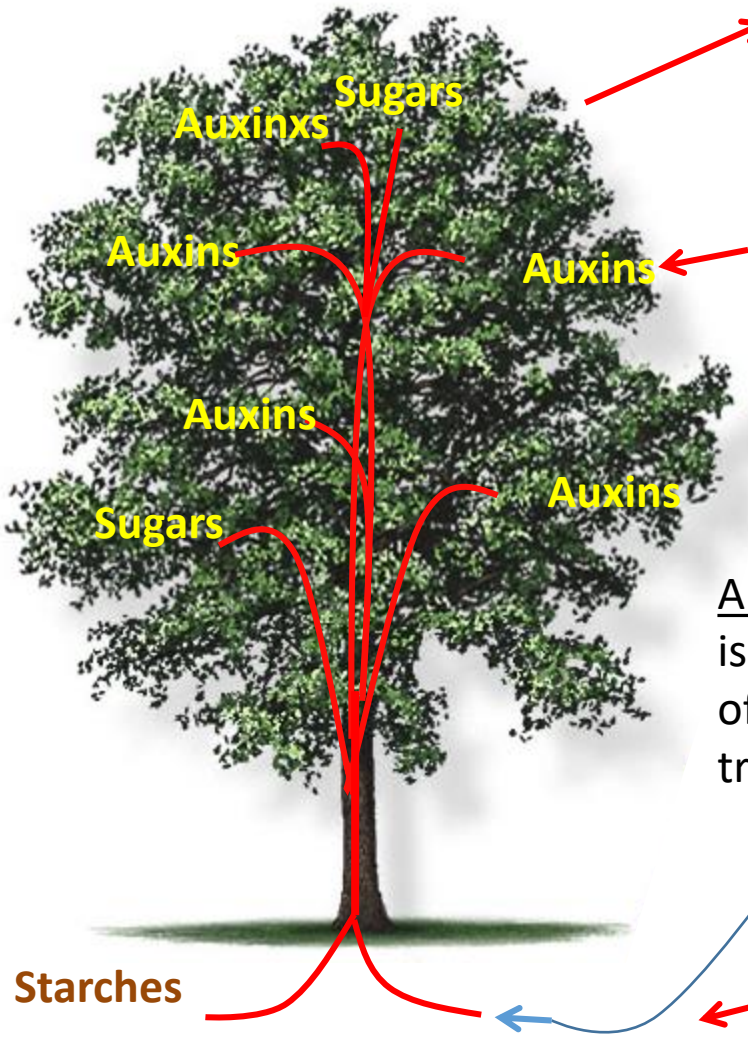
$CO_2 + H_2O + \text{sunlight} \longrightarrow O_2 + \text{fixed carbon (sugars)}$

Cellular Respiration

$\text{Fixed carbon} + O_2 \longrightarrow CO_2 + H_2O + \text{biological energy}$

II. Tree Physiology and Water Transport

Nutrients and Growth Regulators



Transpiration from foliage is the driving force of water transport.

Growth regulators produced at apical meristems to insure proper form through branching patterns, types of foliage, etc.

Absorption of water from soil is necessary to supply demand of the tree in response to transpiration.

Macro- and micro nutrients absorbed with water N, P, K, etc.

What can go wrong?

Tree diseases in Texas

- Herbicides
- Drought, other abiotics
- Declines (numerous species)

Abiotic

- Black spot (elm)
- Oak leaf curl
- Actinopelte on oak
- Leaf rust on oak
- Unkown virus on hackberry
- Brown spot needle blight
- Needle rusts
- Lophodermium needle cast
- Anthracnose (ash)
- Anthracnose (sycamore)

Foliar

- Hypoxylon cankers (hardwoods)
- Mistletoe (true and dwarf)
- Giant dodder (native,exotic)
- Endothia canker
- Botrydiplodia canker
- Phomopsis (and others) tipblight
- Pitch canker
- Cedar x Hawthorne rust
- Fusiform rust
- Crown gall
- Smooth patch

Branch, Trunk

- Bacterial wetwood
- Dutch elm disease
- Oak wilt
- Native elm wilt
- Fusarium Wilt (mimosa)
- Pinewood nematode
- Bacterial leaf scorch
- Fire blight
- Lethal yellows on palms

Vascular

- Ganoderma root rot
- Heterobasidion root rot
- Phytophthora root /crown rot
- Sudden oak death (nurseries)
- Cotton root rot
- Root knot nematode on Pecans
- Heart rots (numerous species)

Root Rots

- Sooty mold
- Ball moss
- Lichens

Non - pathogens

What Can Go Wrong?

Types of Pathogens

Abiotic Pathogens

- Nutrient deficiencies
- Poor water relations
- Climatic extremes
  (early and late freezes, wind damage, etc)
- Air pollution
- Toxic chemicals
- Herbicides

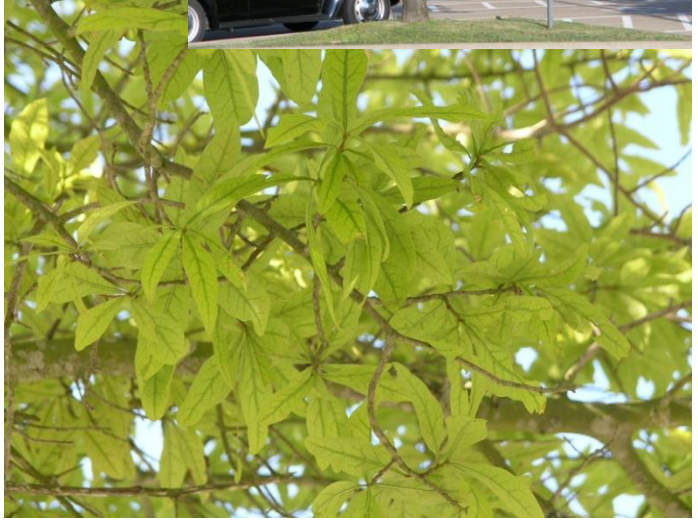
Biotic Pathogens

- Fungi
- Bacteria
- Viruses
- Nematodes
- Phytoplasmas
- Parasitic flowering plants
- Humans and other animals

Example of an Abiotic Pathogen

Iron Chlorosis

- Caused by lack of iron,
- Particularly in high pH soils (> 7.0),
- More of a problem on non-native plants (but not exclusively),
- Also often prevalent on disturbed sites,
- Difficult to correct, but supplemental iron can be used
  - Soil applications,
  - Direct injection of tree.



Example of an Abiotic Pathogen

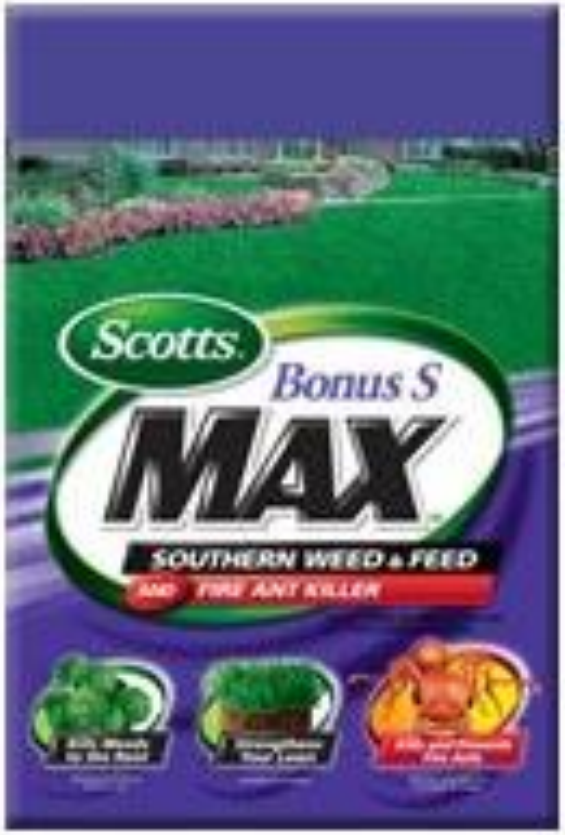
Herbicide Damage - Treaty Oak

Velpar®

Hexazinone - broad spectrum weed and brush control

Weed and Feed with Atrazine

Chlorophyl - inhibiting herbicide



Where Not to Use

"Do not apply under the branch spread (dripzone) of trees and shrubs……"

Example of Abiotic Pathogen

Severe Drought = Severe Stress = Disease

- Trees respond to drought,
  - compensate for the stress,
- If unsuccessful, symptoms develop,
- If sufficiently severe, tree will die.

Example of Biotic Pathogen

Leaf Curl/Blister on Oaks

- *Taphrina quercina*
- Fungus
- Infects in the spring

Examples of pathogens

Abiotic Pathogens

Nutrient deficiencies
Poor water relations
Climatic extremes
Air pollution
Toxic chemicals
Herbicides

Biotic Pathogens

Fungi
Bacteria
Viruses
Nematodes
Phytoplasmas
Parasitic flowering plants

The Declines

Combination of abiotic and biotic pathogens
The most common of tree disease, syndromes
May occur on any species of trees
Symptoms usually similar for different species and locations

Epicormic Shoots

Water sprouts, suckers

- Produced in response to trauma,
  - bad pruning,
  - stress, e.g. drought, root loss, etc.,
- Arise from suppressed buds under bark,
- Loss of apical meristems,
  - lack of auxins,
- Branches are weak, easily break,
- Symptom of a tree in distress.

The Causes of Declines

- the 3 factors

1. Predisposing factors
2. Inciting factors
3. Contributing factors

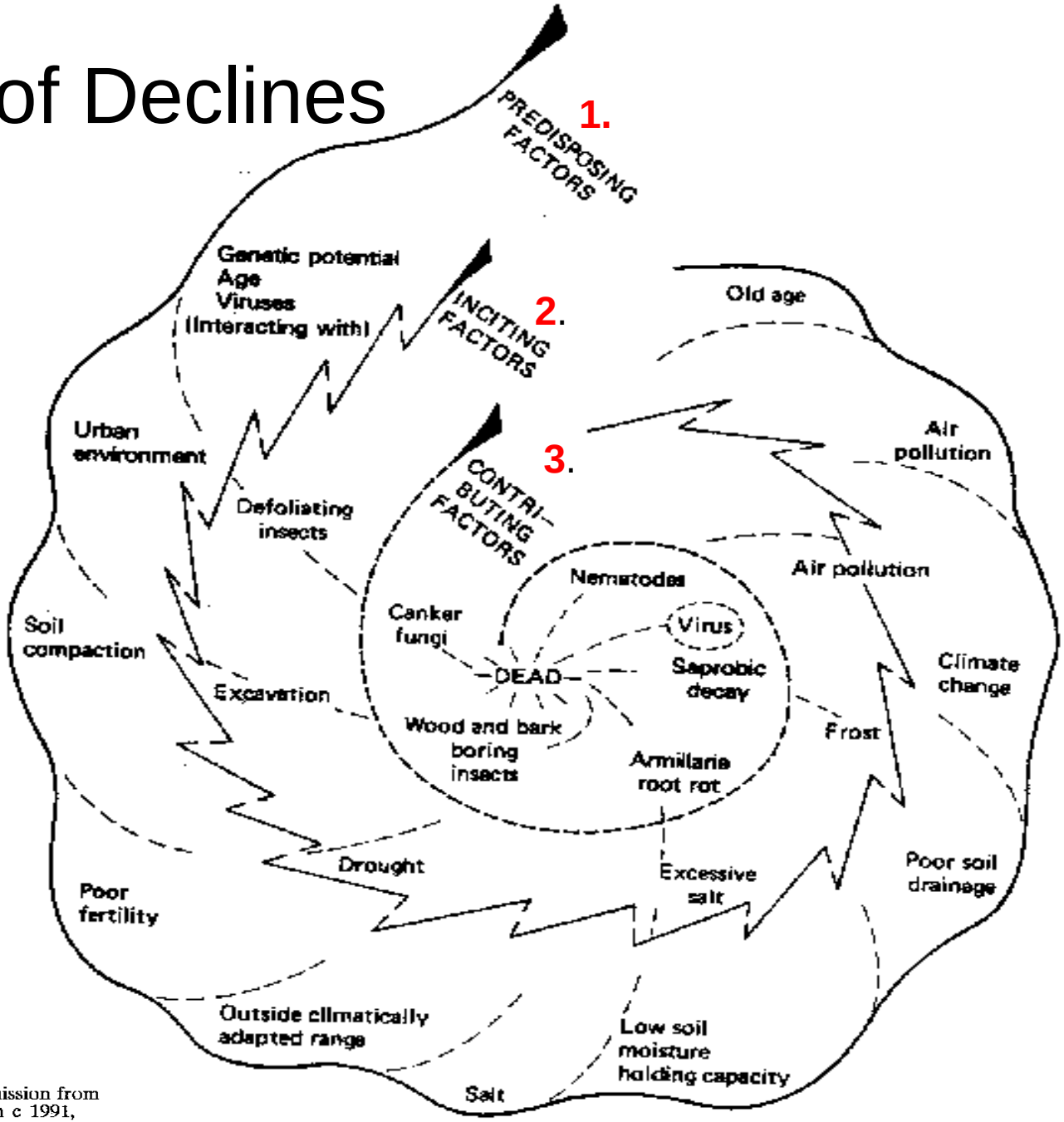


Fig. 1. Decline disease spiral (Reprinted with permission from Tree Disease Concepts by Paul D. Manion c 1991, Prentice-Hall, Inc., Englewood Cliffs, NJ).

Drought Damage In Leakey, TX

II. The Effects of Drought on Trees - Two Categories

What happens in a tree exposed to drought?

1. **Pre – clinical effects**,
   - – physiological,
   - – cannot see them, but can measure them,
2. **Clinical effects**,
   - – Symptoms result,
   - – visible manifestation of host response.

Wilting in a dogwood tree

Mild Drought = Pre-Clinical Effects

- Resource allocation during mild drought stress,
  - Trees must respond to compensate with stored reserves,
    - e.g. osmotic adjustment of cell contents, stomatal closure, root suberization.
  - storage carbohydrates (starches) are mobilized,
  - slight depletions of carbohydrates reserves,
- No external evidence of stress,
  - normal growth, reproduction, defense against pests and diseases.

Moderate Drought = Pre-Clinical or Clinical Effects

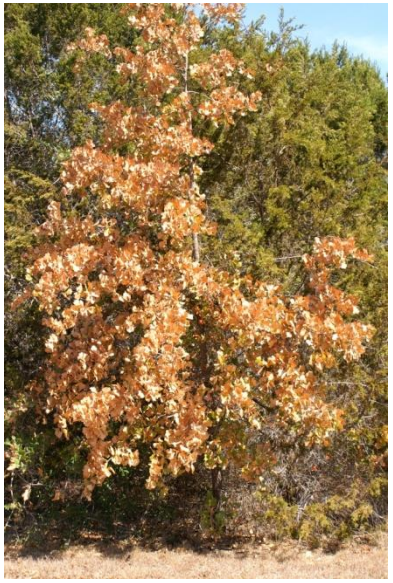
- Resource allocation during moderate drought stress,
  - storage carbohydrates (starches) are mobilized,
  - greater depletions of carbohydrates reserves,
  - tree respond but fail to adequately compensate with stored reserves,
- May be no external evidence of stress, but effects are detrimental.
  - tree cannot grow normally,
  - tree cannot respond to resist pests and diseases,
- There will be long term consequences!

Severe Drought = Clinical Effects

- Resource allocation during severe drought stress,
  - storage carbohydrates (starches) are mobilized,
  - significantly greater depletions of carbohydrates reserves,
  - tree respond but fail to adequately compensate with stored reserves,
- Clear external evidence of stress = symptoms,
  - tree responds to limit damage and survive,
  - wilting, scorching, premature defoliation, twig and branch dieback, death.

Influence of Species Variability

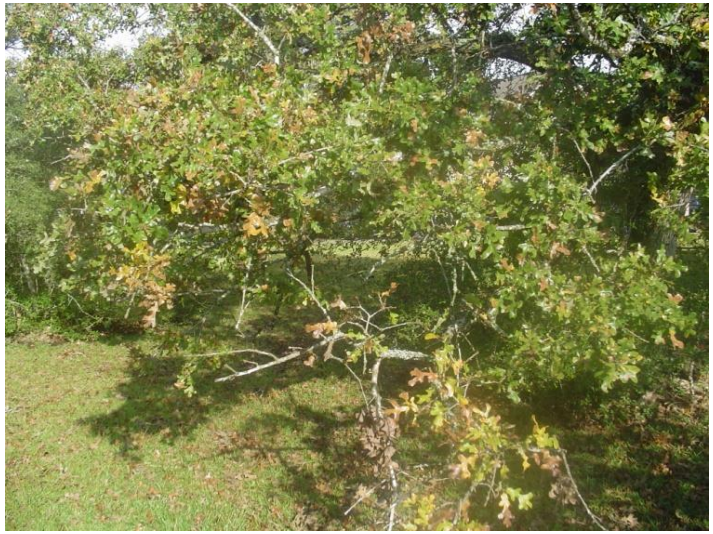
- Any species can be damaged by drought,
- Some are more tolerant than others,
  - Damage will depend on the degree,
- Observations in Brazos County,
  - Water oaks and Blackjack oaks very susceptible,
  - Post oak and cedar elms very tolerant,
- Native trees more tolerant than exotics,
- Many lists available.



Summary of Drought Effects

Predisposing factor, Inciting factor

- Mild drought = mild stress = little strain,
  - no detrimental effects,
- Moderate drought = moderate stress = predisposing strain,
  - wilting, mild scorching,
  - infection by pests and diseases that normally do no harm,
- Severe drought = severe stress = disease,
  - drought becomes a pathogen,
  - dieback, death……



Long-Term Consequences of Drought

Drought as a Predisposing Factor, if Tree Survives

- Weakened, starch depleted trees,
- Unable to respond to pests and pathogens,
  - Normally do them no harm,
  - "secondary", "weak" pathogens,
  - Usually consist of cankers, root rots, wood boring insects = contributing factors,
- Syndrome called "Diseases of Complex Etiology" or Declines.

Tree Diseases Expected to Increase Due to Drought in Texas

Contributing Factors and Their Control

1. Twig and branch cankers,
   - Hypoxylon canker on oaks,
   - native elm wilt on cedar elm,
   - Seridium canker on cypress,
2. Root rots,
   - Ganoderma root ,
3. Bacterial Leaf Scorch,
4. Lophodermium needle cast of pines,
5. Dutch elm disease,

Hypoxylon Canker

Pathogen, Hosts

Post Oak

- *Hypoxylon atropunctatum*,
- a fungus, spread by wind blown spores,

Hypoxylon Canker

Pathogen, Hosts

- *Hypoxylon tinctor*
- Host –

Hypoxylon Canker

Disease Biology

- Non-aggressive facultative parasite,
- Present on healthy trees,
- Some level of predisposition of host required,
- Poor water relations the most commonly implicated source of stress.

Seiridium Canker

Hosts = Arizona, Italian, Leyland Cypress

- *Seiridium unicorne*
- Causes girdling cankers
- Flagging = browning of individual branches,
- May spread to many branches,
- Resin production, oozing,
- Enhanced by winter injury, drought, etc.
- Spread by splashing rain, pruning tools,
- Control: no chemicals, maintain health and vigor of trees, remove injected limbs, plant resistant or immune trees species.

Submitted by: Shane McLellan, CEA

Ganoderma Root Rot

Pathogen, Hosts

- *Ganoderma* spp.
- Occurs statewide,
- A basidiomycete, produces “conks”,
- Wide host range on hardwoods, some conifers.

Ganoderma Root Rot

Disease Biology

- Produces windblown spores,
- Infects through wounds on roots at base of tree,
- Also spreads tree to tree by overlapping roots,
- Stress undoubtedly involved in disease development.

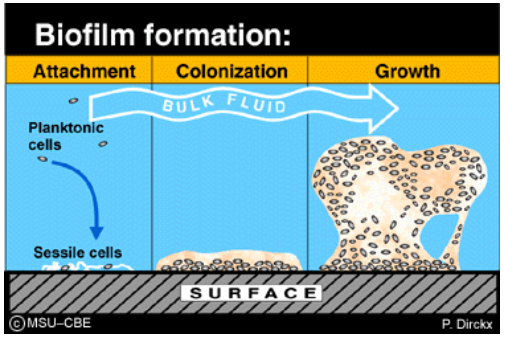
Bacterial Leaf Scorch

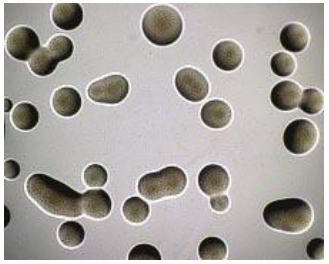
Xylella fastidiosa

- caused by a xylem-limited bacterium, vectored by insects (sharpshooters, leafhoppers)
- many hosts, many strains of the bacterium,
- primary symptom is irregular marginal scorching on affected foliage,
  - appear mid- to late-summer,
  - express on isolated branches and spread,
- slow decline and dieback of affected plants.

Bacterial Leaf Scorch

Disease Biology





- Spread by insect vectors,
  - sharpshooters,
- Produces biofilms,
- Limited by low temperatures,
- Stress probably involved to some degree.

Wood-boring Insects

Flat headed borers

http://bugguide.net/e

Two lined chestnut borer

- Oaks of all species, especially live and post oaks,
- Females lay eggs in bark cracks and crevices,
- Larvae created meandering galleries,
- Girdle branches, trunks, in stressed trees,
- Often start in top, dieback proceeds down through crown,
- Do not attack healthy trees!

Flat headed apple tree

- Many deciduous hosts, shade and fruit trees,
- Adults emerge in spring, lay eggs in bark c
- Larvae burrow into trunks and branches, tu phloem,
- Particularly damaging to young, newly plan older, weakened trees.

Managing Declines
and the Contributing Factors

- Improve tree health, avoid further stress,
- Plant the proper tree for the site,
- Manage fertilization and watering practices,
  - Note vertical mulching,
- Manipulate tree health directly,
  - Cambistat®,
- Remedial pruning,
- Proper pruning,
- Reduce stress.

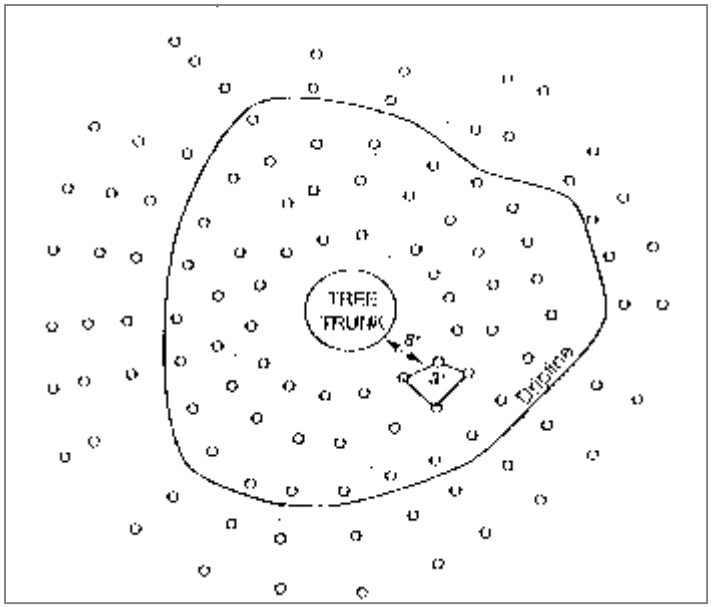
Vertical Mulching for Enhancing Tree Health

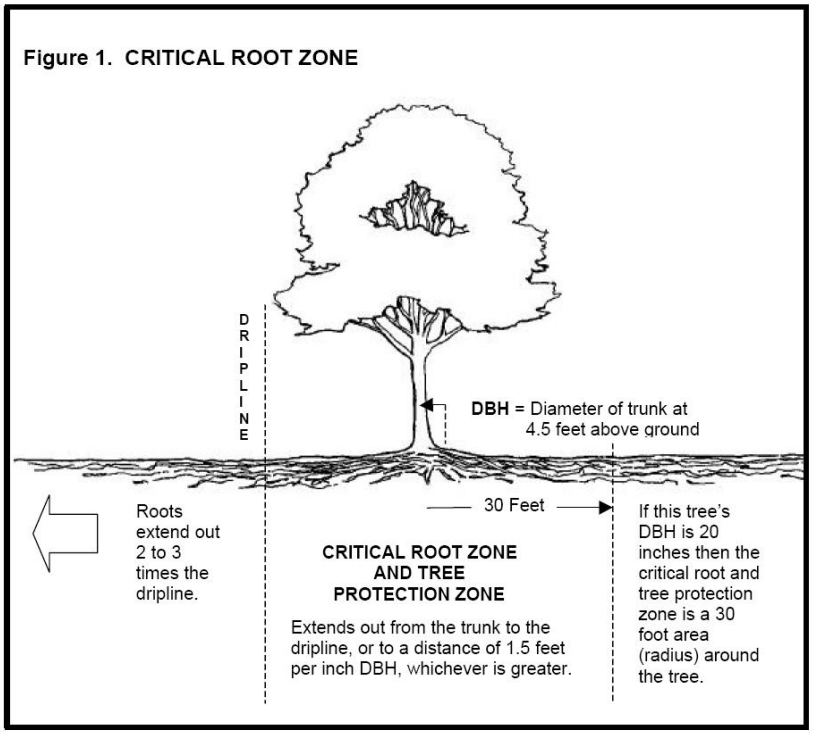
Objectives

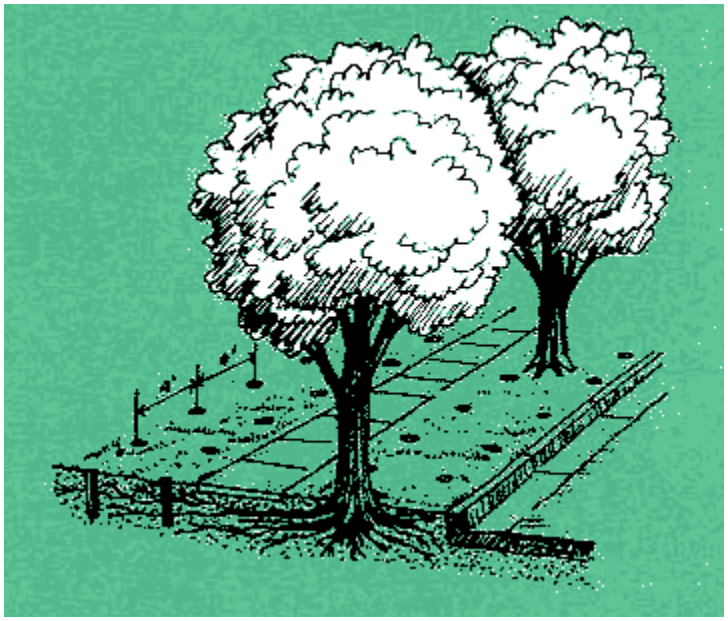
- Improve soil properties,
- Stimulate growth of root system,
- Increase tolerance to soil pathogens,
- Enhance growth of crown and tolerance to canker pathogens, heart rots, and other contributing factors,
- Pan, J.F. 1958. Effects of Vertical Mulching and Subsoiling on Soil Physical Properties. Agron J 51:412-414,
  - decreased bulk density values,
  - increased soil aggregation.

Implementing Vertical Mulching

1. Identify root zone.
2. Drill holes.
3. Fill holes with treatment.







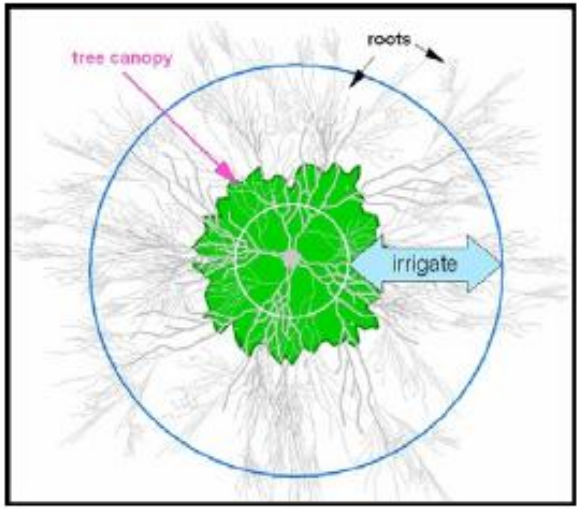
Managing Wood Borers

- Prevention,
  - plant adapted species,
  - proper watering,
  - avoid wounding on trunk,
  - do not stack firewood against trunk,
  - monitor tree health,
- Chemical control (Pest control applicators only),
  - Bifenthrin (ONYX®), permethrin (ASTRO®).

Managing Moderate to Severe Drought

Addressing the Predisposing and Inciting Factor

- Proper diagnosis is critical,
- Supplemental water,
  - for each inch of trunk diameter (width across) measured at knee height, the tree will need about 5 gallons. A 12” tree, then, would need about 5 x 12 = 60 gal of water,
  - the screwdriver technique,
- Do not prune trees during a drought?
- Do not plant trees during a drought?
- Do not fertilize during a drought!
- Mulching,
  - 3 to 4 inches,
  - do not bury the root system!!!
- Prompt removal of hazardous trees,
- Proper selection for replanting,
  - native, adapted plants.



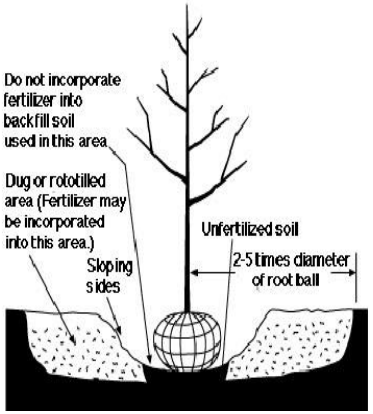
Dealing With Drought at the Landscape Level

- Some evidence from studies in forestry demonstrates that thinning improves trees response to drought,
  - Conventional wisdom is that thinning improves stress response in remaining trees,
- An alternative point of view is that thinning will open a stand to further drying and make matters worse,
- Perhaps a compromise is to remove understory vegetation to reduce competition for resources.

What Else Can Go Wrong?

Poor Management Practices

- Improper planting,
- Fertilizing,
- Water imbalances,
- Over mulching,
- Improper use of pesticides, injections,
- Bad pruning.

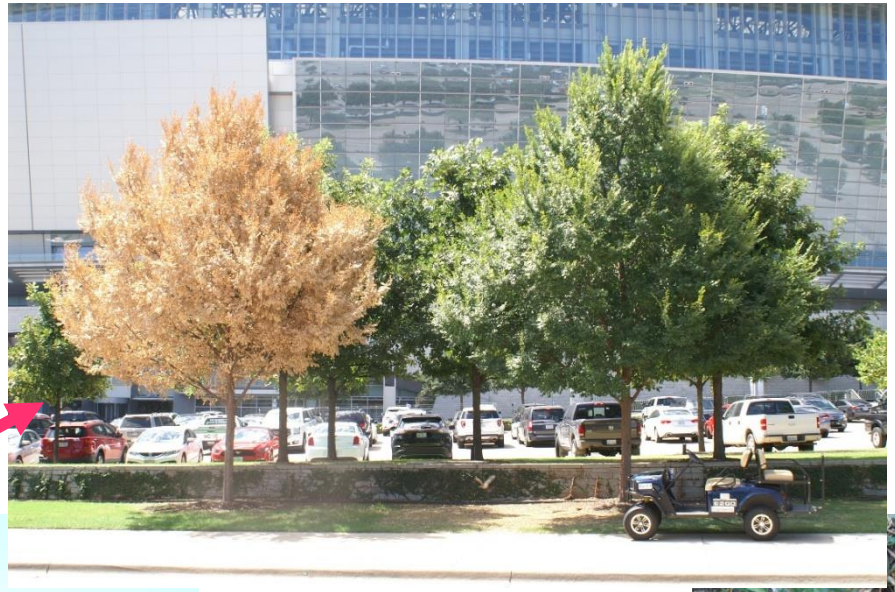


Phytophthora root and crown rots

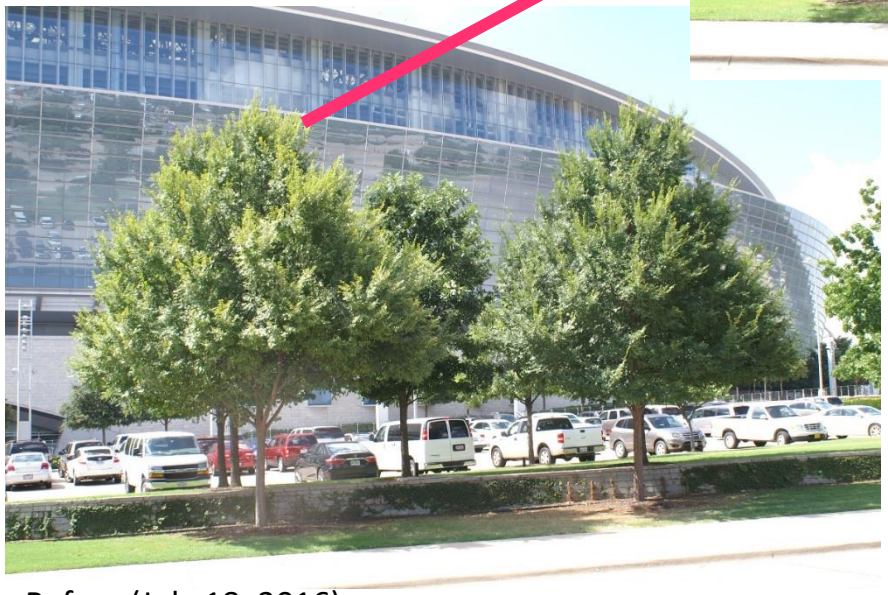
boxwood, azalea

- Many hosts,
- Excessive yellowing and loss of foliage,
  - N fertilization may temporarily alleviate symptoms,
  - some wilt,
- Incidence depends on excessively moist soils, shaded conditions, fertilization,
- Internal discoloration of roots,
  - advancing from smaller roots to larger roots and crown,
- Gradual to sometimes rapid death of plant.

Cotton Root rot on *Ulmus*



After (21 days, Aug. 8, 2016)



Before (July 18, 2016)

Fungal pads

Oak Wilt in Central Texas

The Biology, Epidemiology, Diagnosis
And Control

David Appel
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Texas A&M University,
College Station, TX 77843

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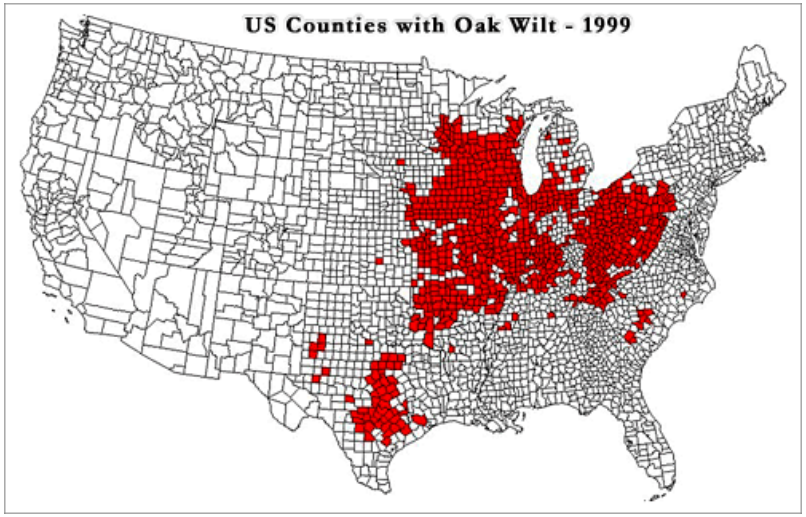
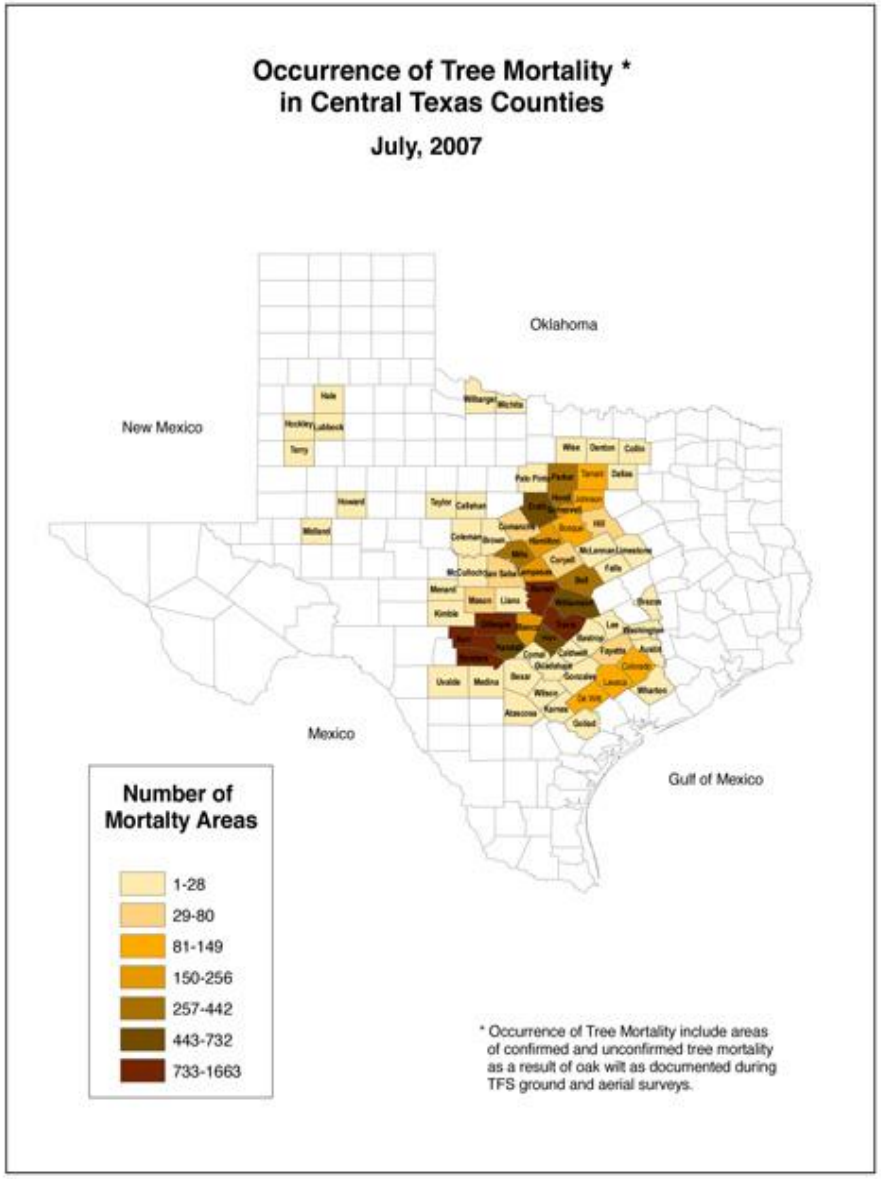
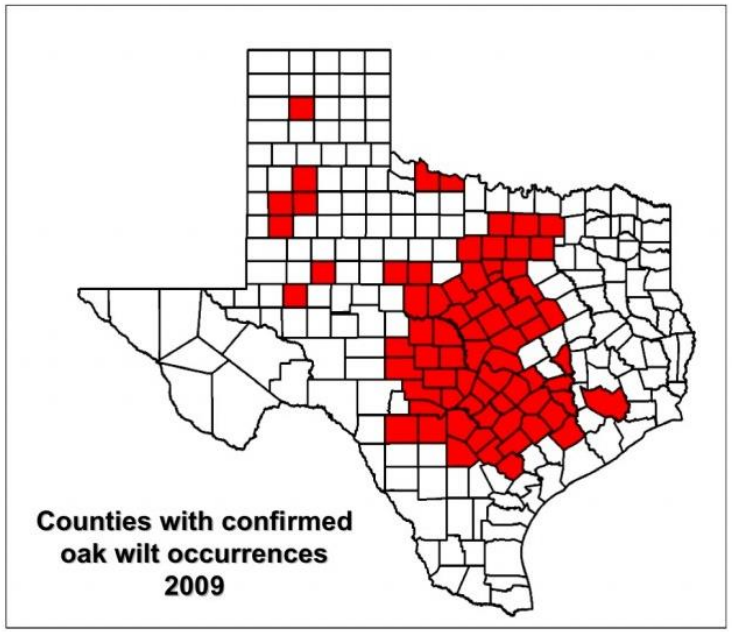
Background on Oak Wilt

- First described in 1941 in Wisconsin,
- Considered to be a significant threat to oak resources,
- 40 years of research and management,
  - proven to be significant in Texas in 1980s.



Oak Wilt Distribution - Texas





Impact in Texas











Why Did Oak Wilt Become Epidemic in the Live Oak Savanahs of Central Texas?

Species Composition and Stand Structure

- Tree community and structure,
  - Dominance of live oaks and red oaks,
- Past Influence of European settlement and land use practices,
  - Fire control,
  - Overgrazing,
- Current wounding…..

Oak Wilt Biology, Interacting Factors

Ceratocystis fagacearum

- A fungus.
- A vascular parasite (means it kills healthy trees),
  - Poor saprphyte,
- Produces two kinds of spores,
- Forms mats of tissue under bark on certain trees,
- Heat sensitive,
- Occurs in 22 other states, but origin unknown.

Oak species affected by oak wilt in Texas

RED OAKS = Susceptible, extremely

Q. texana	Spanish Oak
Q. marilandica	Blackjack Oak
Q. nigra	Water Oak

WHITE OAKS = Resistant, less susceptible

Q. sinuata var. breviloba	Shin Oak
Q. glaucoides	Lacey Oak
Q. polymorpha	Mexican white oak
Q. stellata	Post Oak

LIVE OAKS= variable

Q. virginiana	Southern live oak
Q. fusiformis	Plateau live oak

Oak Wilt Disease Cycle

Infection of *Quercus* spp. by *Ceratocystis fagacearum* in Texas

Nitidulid Beetles

Mat Formation

Contaminated Nitidulids = "Overland spread"

wound

1. Red Oak Phase

Dead Red Oak (next spring)

Dying Red Oak (Fall)

Infected Red Oak (late summer)

Infected Red Oak (early summer)

Dead

Healthy red oak

Healthy live oak

Root connections

No mats, no beetles

"Local spread" = Rapid, spreading Live oak mortality

2. Live Oak Phase

Diseased Live Oak

Root Connections

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Improving Lives. Improving Texas.

Prepared by D.N. Appel
March 2011

Oak Wilt Control Options

- Always starts with diagnosis,
- Prevention - avoid wounding in spring,
  - Feb. 1 through end of June,
- Prevention - use wound paints,
- Prevention - cautious movement of firewood,
  - Cover when necessary,
- Direct control – trenching,
- Direct control - intravascular injection with fungicides,
- Plant resistant trees.

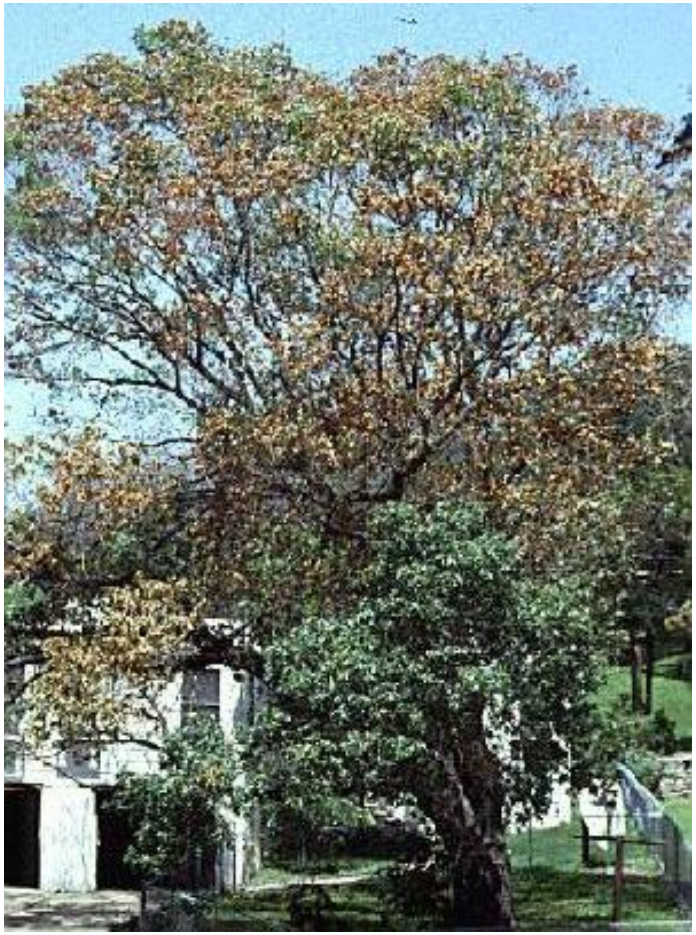
Oak Wilt Diagnosis

1. Pattern of disease in the population of trees

Live Oak Center vs. **Red Oak Center**

2. Pattern in individual trees

Diseased Live Oak vs. **Diseased Red Oak**



3. Foliar symptoms

Live Oak Symptoms vs. Red Oak Symptoms

4. Presence of fungal mat

Only red oaks

5. Taking Samples

- **Bole and Branch Samples**
- **Confirm presence of pathogen**

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Texas Plant Disease Diagnostic Lab

The Texas Plant Disease Diagnostic Laboratory, located in College Station, Texas, is a service lab of the Department of Plant Pathology and Microbiology at Texas A&M University in conjunction with Texas AgriLife Extension Service.

Sending Samples?

Please check calendar or call 979.845.8032 for diagnostician availability prior to sending samples.
Sample Submission Form

PlantClinic Tweets

Fr. Arborage: A good Q&A on urban tree stress and factors contributing to it. http://bit.ly/hiRAR8

My TNLA Green column - proactive planning for plants problems in green industry. http://bit.ly/ggg8Ig

More updates...

Blog

Seen in 2011 at the Plant Clinic

Plant Clinic magnets for 2011

Season greetings from the TPDDL

Crazy Texas temperatures

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Packaging for Oak wilt

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Management

The Nitidulid Connection

- Prevent mat formation,
  - deep girdling,
  - strip bark,
  - destroy the diseased red oaks.
- Avoid wounding,
  - February 1 – June 30,
  - use wound paints.

Oak Wilt Control Options

- Always starts with diagnosis,
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- Direct control – trenching,
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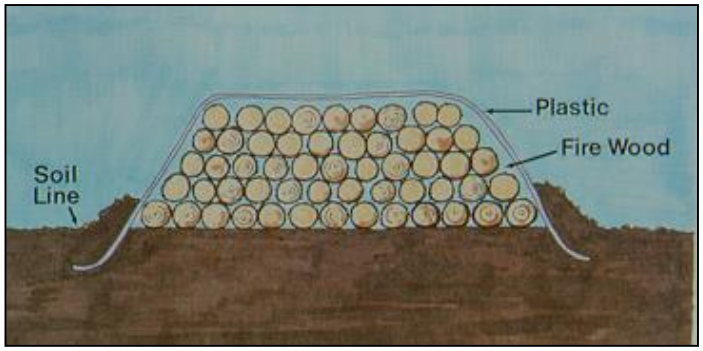
Contaminated Firewood

- Should be seasoned (well dried),
- Fire kills all living things – burn during season,
- Cover infected red oak logs with clear plastic,
- *C. fagacearum* is killed by high temperatures > 36ºC.



Oak Wilt Control Options

- Always starts with diagnosis,
- Prevention - avoid wounding in spring,
  - Feb. 1 through end of June,
- Prevention - use wound paints,
- Prevention - cautious movement of firewood,
  - Cover when necessary,
- Direct control – trenching,
- Direct control - intravascular injection with fungicides,
- Plant resistant trees.

Trenching – Types and Placement

- Trenching (at least 4 feet deep) to halt oak wilt spread through connected root systems

- Roguing (removal of diseased trees within trenched area)

Trenching – Types and Placement

Belt Trencher

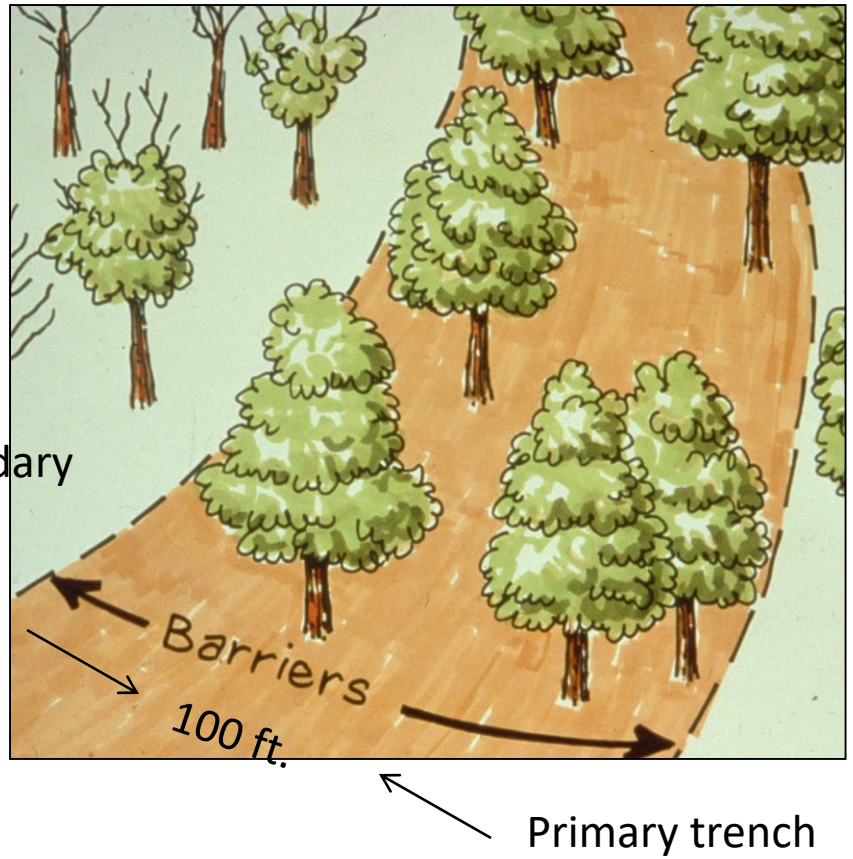
Back Hoe

Ripper Bar

Rock Saw

Trenching – Types and Placement

Within trench you need to remove all host material



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Fungicide – Technique and Implementation

- Used on trees under disease pressure- on advancing margin of disease centers
- Therapeutic and Preventative – rate based on size of tree
- Expose root flares & Inject on root flares – high volume low concentration

Alternative Products and Techniques

Propiconazole 14.3
Fungicide

Criteria for Successful Oak Wilt Treatment

- Reliable,
- Verifiable documentation of research results,
- Must increase survival of treated trees over natural population,
- Safe,
- Economical,
- Reasonably easy to apply.

Oak Wilt Control Options

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http://texasforestservice.tamu.edu

'Planting Guide'

http://texastreeplanting.tamu.edu/

Texas Tree Selector

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Texas Tree Planting Guide

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Express Tree Selector
The quickest way to find the best trees for your yard

Custom Tree Selector
Gives you more choices for trees to plant in your yard

Tree Planting & Care
More info to help you buy, plant and care for your new tree

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http://texastreeplanting.tamu.edu/ExpressSelector.aspx

Texas Tree Selector

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Express Tree Selector

Please select your county:

Williamson

What size tree would you like:

- Small
- Medium
- Large

Click to view Tree Heights graphic

Show Trees

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Texas Tree Planting Guide

TEXAS A&M FOREST SERVICE

Recommended medium trees for Williamson county

Bigtooth Maple

Acer grandidentatum
Leaf Type: Deciduous
Comments: Hill Country native. Good for moist, well-drained limestone soils; handles shady sites.

More About this Tree

Mexican White Oak

Quercus polymorpha
Leaf Type: Deciduous
Comments: Also known as 'Monterrey Oak,' this species is rapidly becoming used as an urban landscape tree.

More About this Tree

Eve's-Necklace

Sophora affinis
Leaf Type: Deciduous
Comments: Requires well-drained site; fruits are avoided by wildlife.

More About this Tree

Texas Ash

Fraxinus texensis
Leaf Type: Deciduous
Comments: Good long-lived shade tree. Prefers loamy, well-drained soils, but works on dry sites as well.

More About this Tree

http://texastreeplanting.tamu.edu/CustomSelector.aspx

Texas Tree Selector

Texas Tree Planting Guide

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Custom Tree Selector

I will plant my tree in this county: **Please Select**

Option 1: The space available for my tree is...

- **A small area**, less than 120 sq.ft. or with growing space restrictions (overhead wires, on the sides)
- **Somewhat restricted**, less than 180 sq.ft.
- **A large space**, more than 180 sq.ft.
- **Not sure**

Click to view Available Space graphic

Option 2: I want a tree that is...

- **Small**, 20 ft. tall or less at maturity
- **Medium**, 20-40 ft. tall at maturity
- **Large**, more than 40 ft. tall at maturity
- **No preference**

Click to view Tree Heights graphic

Option 3 : I want a tree with leaves that are...

- **Deciduous**, leaves drop in fall
- **Evergreen**, leaves stay green all year
- **No preference**

Option 4 : I want a tree that... (check all that apply)

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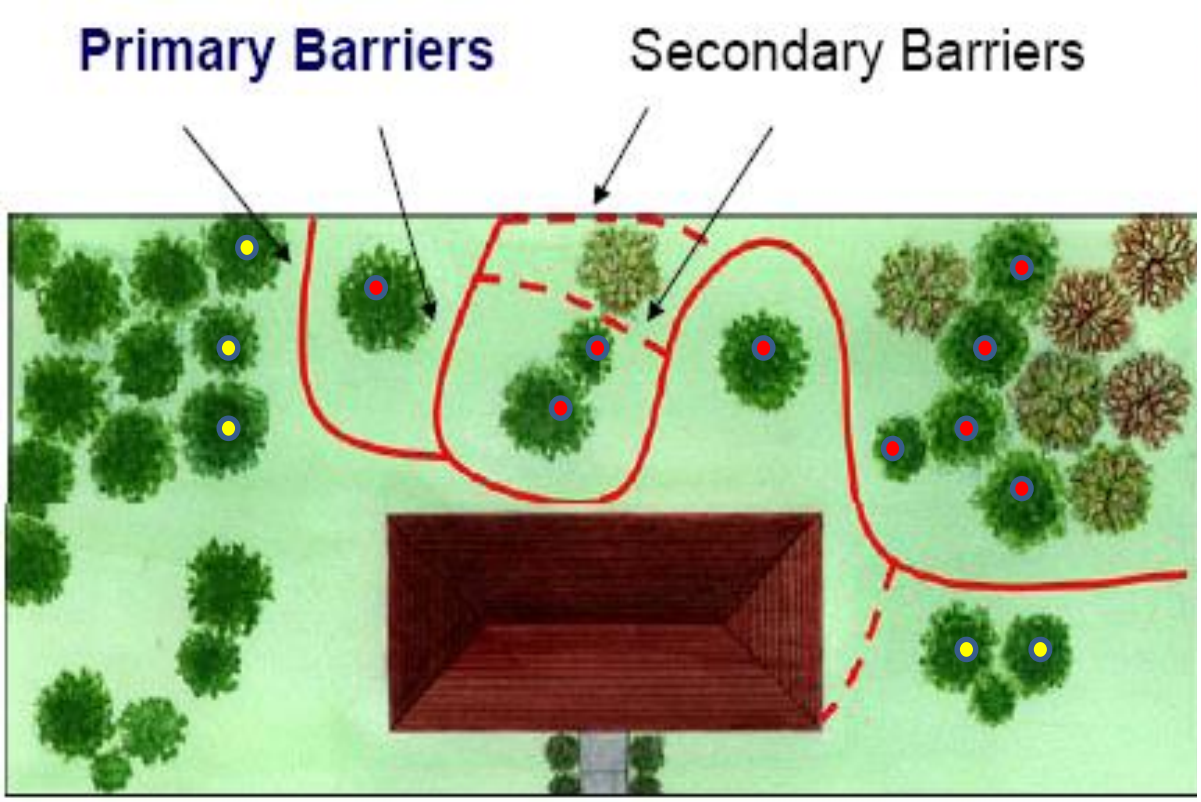
Decision Making for Oak Wilt Treatment

Integrated Program



● = candidate for therapeutic injection

● = candidate for preventative injection

Need Help?

- Texas Forest Service
  - http://texasoakwilt .org

TEXAS OAK WILT INFORMATION PARTNERSHIP

- Texas A&M AgriLife Extension Service
  - Texas Plant Disease Diagnostic Lab
  - http://plantclinic.tamu.edu