

Tree Health in Minnesota

PICKM Fall Event
Kanabec History Center
October 22, 2013

PICKM is a 5 county group of Master Gardeners in Minnesota: Pine, Isanti, Chisago, Kanabec and Mille Lacs.

Definition 1: Tree Health

- Photosynthesis
- Respiration
- Adequate Energy Reserves



Tree health can be described or evaluated by three criteria: How much chemical energy has it created from light energy (photosynthesis)? How much chemical energy has been released for growth and normal functions (respiration)? How much chemical energy has it stored as a reserve for growth, recovery, tolerance to stresses (energy reserves)?

Photosynthesis



Photosynthesis (PS) is the transfer of light energy to chemical energy (sugars). This is the building block step for all plant functions. If PS is abnormally low for any reason, the tree will be not be able to operate normally.

Normal Photosynthesis



- Normal Sunlight
- Normal Chlorophyll a
- Normal Carbon Dioxide
- Normal Water
- Normal Temperatures

Yew (*Taxus*) stomata and guard cells



For PS to perform normally, there must be adequate light energy for that plant's requirements – remember, some plants do well in the shade of other plants, others must have full, uninterrupted sunlight – enough chlorophyll a present since that's the site where photosynthesis actually occurs, enough carbon dioxide available for the chemical conversion, enough water available for both the chemical conversion and to keep the stomata open (underside of leaves, openings that allow gas exchange with the environment) so carbon dioxide can enter the leaf, and normal temperatures for PS to operate normally (generally, under 85-90 degrees F, and above 40-45 degrees F).

Photosynthesis

- Normal PS



- Abnormal PS



Respiration

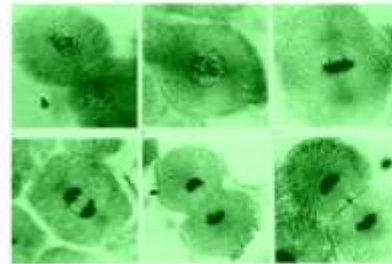


Respiration (RS) is the release of the chemical energy created from PS for all plant activities that require energy or require energy to start a process. Unlike PS, RS takes place in every living cell. If it doesn't, the cell doesn't live, and it doesn't matter if it's a leaf, shoot, flower, fruit, bud or root cell.

Normal Respiration



- Normal Energy Source (sugars, starches)
- Normal Oxygen
- Normal Water
- Normal Temperatures



Leaf Mitosis: 1 Cell becomes 2

Respiration can't proceed if there's not a (chemical) energy source, the sugars/carbohydrates that result from photosynthesis. As opposed to PS, RS requires oxygen to complete the chemical release of energy, as well as water. Too much water usually means too little oxygen (think of flooded soils). Too much oxygen often means too little water (think of droughty, sandy soils). And like PS, temperature extremes slow down or almost stop respiration...that's why fresh fruits and vegetables are put in refrigerators, to slow down respiration which keeps the plant part from using all of the energy reserves (sugars, carbohydrates) before they can be put in a salad and enjoyed by people.

Respiration

- Normal



- Abnormal



Respiration is racing along in the scene to the left, at every level...trees, shrubs, vegetables. On the right, the tree is still alive, but barely. It's not growing at any measurable rate, and it's certainly not capable of tolerating many more stresses before it declines further and dies. Do you wonder if the roots are getting that desired mix of just the right amount of water and oxygen?

Energy Reserves



At the end of a normal growing season (close to 165 days of PS), with a normal amount of leaves to PS, little to no death of woody plant tissues, there is an adequate amount of energy stored to keep the tree functioning normally, able to tolerate and recover from most common stresses and able to leaf out again next spring. In Minnesota, mid-September is usually the best time to evaluate a tree's energy reserves because it has gone through the growing season with all of its stressful events and a tree health expert can often visually evaluate the reserve levels based on the tree's PS record for the summer and the amount of storage tissue remaining in the trees.

Normal Energy Reserves



- Complex Carbohydrates
- Stored in All Tree Parts
- Carbohydrates Broken Down into Sugars for Energy



Energy is most often stored as a complex carbohydrate, a more stable way of storing energy than as a simple sugar. Reserves are stored in just about every part of the tree that is still living or functional: buds, twigs, “living” bark, roots, wood. When energy is required for any plant metabolic activity, the reserves are called upon, broken down into the simple sugars, and the energy is released for growth, recovery, tolerance, and on and on.

Energy Reserves

- Normal



- Abnormal



Wood is a storage location for a lot of energy reserves, especially in the sapwood and the parenchymal rays, those faint lines that run radially from the center of the branch or tree trunk to the outer edges. If decay enters a branch or trunk, that area of storage is lost...forever, and the ability of the tree to grow and recover from stresses is compromised to some degree. If a tree's branches are over-pruned at with the topped trees, again, large areas of potential energy storage are lost. Also, topping always leads to plugging up (discoloration) of the wood and to some extent, decay.

Definition 2: Tree Stress

- *An interruption or degradation of essential metabolic activities resulting in reduced growth, reproduction and/or tolerance*

A Stressed Young Tree



Young trees are normally/abnormally stressed until they eventually redevelop a characteristic root:shoot ratio. When trees are transplanted, whether from a field nursery or a containerized nursery, they are stressed due to root loss. Early fall coloration, tip die back, thinned canopies, smaller than normal leaves are characteristic for this 1-5 year period. They are stressed and therefore PS and RS is abnormally low. The key is to acknowledge that and remove as many of the other stresses as possible, mostly water stresses.

A Stressed Established Tree



When established trees, trees that have been in the landscape for more than 10 years or so (that's an arbitrary number), they should have developed a normal root:shoot system. These maples are showing some typical stress symptoms for established trees. Their canopies are thin, the leaves are smaller than normal, and are chlorotic, especially the maple to the right.

A Stressed Semi-Mature Tree



These trees are well-established yet are exhibiting typical stress symptoms, signals that something is interrupting their normal metabolic (PS,RS, digestion, protein synthesis) activities. Very thin canopies for maples that should be as dense as a wall. More extensive die back. These trees are likely to continue this decline and prematurely die unless there's an intervention and correction of the problem/s with them.

Definition 3: Tree Disorder

- *A response to a metabolic abnormality:*
 - *Photosynthesis*
 - *Respiration*
 - *Energy storage*

Abnormal Photosynthesis



This freeman maple has barely any chlorophyll a left in its leaves, for whatever reason. As a result, they cannot be photosynthesizing normally, creating the chemical energy the tree will need for all functions.

Abnormal Respiration



Likewise, the roots of these growing trees are not growing any more. Flooded soils during the growing season have very little oxygen in them. The pore spaces are largely filled with water at the expense of oxygen. Fine roots, those that take up water and nutrients, are constantly dying and then regularly replaced with many more new roots. If oxygen is deficient, RS cannot progress normally, releasing that energy from sugars that tree roots depend upon for growth. Depending on how long this area remains flooded during the growing season, the trees may only be slightly set-back/stressed or they may die. If the flooding occurred during the winter or frozen soil season when the trees were resting rather than actively growing, the danger of stress or death would be much less.

Abnormal Energy Storage



This large basswood, previously vertical, has hardly any energy reserves in the functional wood of its trunk due to extensive decay and discoloration. Discoloration occurs when phenolic chemicals fill up the conductive tissues, usually in response to a wound or a wilt disease pathogen. Whatever the reason, those tissues are plugged up and no longer serve as an energy storage area for the tree.

Definition 4: Decline

- *A progressive reduction in energy reserves due to predisposing, inciting and contributing factors*

Primary Predisposing Factors

- Chronic Water Stress
- Chronic Defoliation

U.S. Drought Monitor
Minnesota

October 15, 2013
(Released Thursday, Oct. 17, 2013)
10:17 a.m. EDT



Drought Conditions (Percent Area)

	None	Green	Yellow	Orange	Red	Dark Red
Current	35.4%	34.9%	25.2%	3.9%	0.0%	0.0%
Last Week	35.4%	35.2%	25.2%	3.9%	0.0%	0.0%
10-Day Avg	35.4%	35.2%	25.2%	3.9%	0.0%	0.0%
30-Day Avg	35.4%	35.2%	25.2%	3.9%	0.0%	0.0%
Year to Date	35.4%	35.2%	25.2%	3.9%	0.0%	0.0%
Year to Date	35.4%	35.2%	25.2%	3.9%	0.0%	0.0%

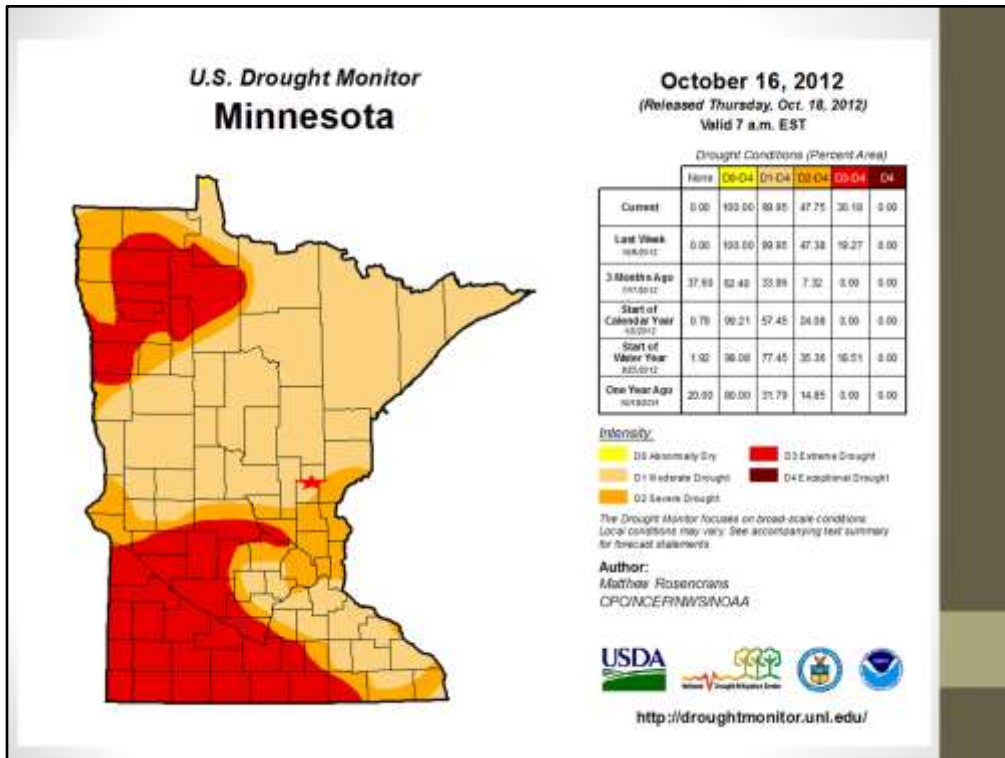
Legend:
 Green: No Drought
 Yellow: Moderate Drought
 Orange: Severe Drought
 Red: Extreme Drought
 Dark Red: Exceptional Drought

* The United States Drought Monitor is a joint project of the National Oceanic and Atmospheric Administration, the National Drought Mitigation Center, and the University of Nebraska-Lincoln.

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USDA
 NDM
 NOAA
 NDM
<http://droughtmonitor.noaa.gov/>

Predisposing factors are those that “set plants up” for failure. They are chronic, meaning they last for a long time (several seasons) or repeated regularly for a long time. Chronic water stress (repeated seasonal flooding or multi-year drought or drought-like stress) and chronic defoliation (close to total defoliation in multiple years) are the most common and most detrimental predisposing factors. Both conditions negatively affect PS and RS. Memories of weather conditions do not often reflect accuracy. Note the US Drought Monitor report for October 15, 2013, and the star on Kanabec County. It doesn’t look too bad, courtesy of recent rainfall events. The worst case for the county is a section classified as moderate drought. This could lead people in that area to discount drought as a health factor.



The same Drought Monitor report one year earlier. Note at this time, the county was classified as Moderate to Severe drought territory. Since it takes trees so long to physiologically respond to environmental stresses, the symptoms of damage to the drought a year ago didn't start until the growing season of 2013 and continues to this day, despite the recent drought assessment. The US Drought Monitor is a powerful and reliable diagnostic tool for tree health professionals.

Chronic Water Stress: Long-Term Drought



The maples on the left and the birch on the right have been suffering and declining for several years due to several seasons of drought in western MN. Obviously, the birch has finally died, but the maples are not far behind. Lots of die back, thin foliage, stunted growth and nothing being done about it.

Chronic Water Stress: Drought-like Conditions



Even if rainfall is normal and adequate for healthy tree growth, the site may present a chronic drought-like situation. These two trees are planted in seas of pavement, with lots of heat radiating from the pavement causing the trees to transpire more to cool off and little surface area that can absorb rain water...a drought-like situation despite the weekly rainfall amounts.

Chronic Water Stress: Long-term Waterlogged Soil



An in areas of chronic drought, there can be stresses from the opposite water extremes. In low spots such as this scene, water can be funneled from a large watershed, stand in low areas like this if the drainage is poor and end up causing tree death due to flooded soils even during periods of drought. It gets worse if the property-owner irrigates the turfgrass.

Chronic Defoliation: Leaf-feeding Insects



Photo: Bugwood.org

Annual defoliations, more than 50% of the tree's foliage per defoliation is the other, major predisposing factor. No leaves, no chlorophyll or little chlorophyll, severely reduced photosynthesis. These trees have all been annually defoliated by leaf-feeding insects.

Chronic Defoliation: Fungal Leaf Diseases



Anthracnose on Black Ash Stand

Fungal diseases, such as anthracnose, can be just as harmful if they occur several seasons in a row. A healthy tree can tolerate and recover from a season's defoliation, but not several seasons of it.

Chronic Defoliation: Fungal Leaf Diseases



Cedar-Hawthorne Rust on English Hawthorne – September 10, 2013

Normally, diseases such as cedar-hawthorne rust are not a big concern beyond the aesthetics of it. However, this case is different, with complete defoliation by late summer, every year. This is a good example of either remove the trees or put them on a preventative spray schedule to minimize this predisposing situation.

Inciting Factors

- Shorter in Duration
- Infrequent
- Environmental
- Mechanical Injuries
- Chemical Damage

Inciting Events: Loading Events



The second part of the “decline spiral to death” involves inciting events. These events or factors are usually shorter in duration or their frequency is random, such as the damage left by wind loading events. If the trees are severely damaged such as this case, it’s the end. However, if the damage is ripped branches and exposed trunk wood, the tree can survive if it’s healthy. If it has been predisposed by other factors, though, inciting events can sometimes be the “straw that breaks the camel’s back.”

Inciting Factors: Non-target Spray Drift



Glyphosate Damage to Apple (left), Maple

Accidental herbicide drift rarely kills healthy plants, but if the plant has been previously stressed, this can be the final insult.

Inciting Event/Factor: Deicing Salt Drift



The same can be said for deicing salt spray drift. Normally, drift only disfigures trees, but repeated drift damage to stressed trees can finish them off. Deicing salt that runs off into the soil around trees is a different story, though. The chlorine in most salts is toxic to root tissues and also creates a short-term water imbalance in the soils. Therefore, run-off is more likely to directly kill or severely damage tree health due to the damage to the root system.

Contributing Factors

- Opportunistic
- Biotic
- Complete the Circle of Life

Contributing factors are the “clean-up organisms,” attracted to severely weakened plants. Unfortunately, they are often the problem that people actually see and therefore blame for the death of the tree, when in fact they are just finishing off an already dead or dying tree.

Contributing Factors: Fungal Target Cankers



Fungal target cankers are classic contributing agents. They infect stressed trees, primarily drought-stressed trees, and enter the tree's trunk through previous wounds.

Contributing Factors: Wood/Bark Boring Insects



Most, but not all, wood-boring insects are attracted to stressed trees and only finish the job of tree death. Yet, they are so obvious that a lot of effort and money is spent on killing the insect rather than curing the stress problem.

Contributing Factors: Scale Insects



Scale insects tend to proliferate and finish off stress trees: oaks, elms, magnolias in particular.

Contributing Factors: Root Rot Pathogens



Armillaria Root Rot

Armillaria is a soil-borne fungus that is just about everywhere in Minnesota. Normally it finishes off old, declining trees. When it infects a younger tree, it's only because that tree is predisposed by something else that's declining its health, most often water-related problems.

Definition 5: Abiotic Causal Agent

- “A non-living causal agent of a disease, disorder or damage...”

Abiotic Causal Agent: Propiconazole



Even good chemicals can cause bad things to happen. Propiconazole is an effective chemical for treating oaks with oak wilt, a fungal, vascular disease that is sure death to red oaks, slow death to white oaks. However, if the chemical is applied during hot, droughty times of the year, tissue death such as this often occurs. So, the causal agent, the factor that caused the damage, is a non-living chemical...an abiotic agent of damage.

Abiotic Causal Agent: Ice Damage



Same with ice storms. Lots of damage from a non-living causal agent. There are no pesticides that can control abiotic causal agents.

Definition 6: Plant Pathogen

- *“A plant pathogen is a disease-causing organism which attacks plants.”*

A pathogen is a living (biotic) causal agent. Diseases are caused by pathogens, which can include fungi, bacteria, viruses, etc.

Plant Pathogen: Powdery Mildew



Fungal Pathogen

Powdery mildew is a common disease caused by a fungal pathogen, a biotic causal agent.

Plant Pathogen: Ash Yellows



Phytoplasma-like Organism

Ash yellows is a decline disease of ash trees and lilacs in the Upper Midwest and is caused by a biotic causal agent, a phytoplasma-like organism (PLO).

Definition 7: Infectious

- *“spreading or capable of spreading rapidly to other Hosts...”*

Diseases don't spread, pathogens spread. Infectious pathogens are those that are worrisome because they have the potential to spread from one host plant to another easily and quickly. The challenge is to find out how they spread: by wind, rain, by a vector (insect, pruning shears) or by grafting.

Infectious Diseases: Fireblight



Bacterial Pathogen

Fireblight is an infectious disease unique to plant members of the Rose family and is caused by a bacteria that moves via water, pollinators or pruning shears/saws.

Infectious Disease: Venturia Blight on Poplar



Fungal Pathogen

A similar-looking disease is poplar blight, but is caused by a fungal pathogen that spreads by windborn spores infecting new tissues.

Infectious Diseases: Dutch Elm Disease



Dutch elm disease is caused by an insect vectoring (carrying/transporting) a fungus (*Ophiostoma*) that can then spread from one elm to another via root grafts (>80% of DED in cities was spread by root grafts).

Infectious Diseases: Phytophthora Canker



Phytophthora canker and root rot is a disastrous disease to growers. The fungus spreads from one tree to another via water-carried spores.

Definition 8: Incidence

- *“Damage or losses are acceptable...aesthetically, economically, health-Wise”*

Not all diseases or disorders are problems. Sometimes they are acceptable at some level and are therefore termed “an incidence.”

Incidence: Black Knot on Cherry



Fungal Pathogen

Black knot on cherry is so common with many landscape cherries (e.g., Canada Red cherry) that it's almost expected. Although it can eventually cause the death of the tree if not pruned out promptly, it's generally not considered a problem...more of an annoyance or a cocktail party topic of conversation.

Incidence: Tar Spot on Maple



Fungal Pathogen

Tar spot on maple is very common where overhead irrigation systems are used or anything encourages humidity/wet leaves. It won't kill the plant, but it does scare tree owners.

Incidence: Hackberry Mosaic Virus



Hackberry mosaic virus is almost an aesthetic addition to the landscape, rather than a killer of trees.

Incidence: Viral Witches Broom on Hemlock & White Fir



One of the symptoms of viral infections is stunt. Some of the more popular dwarfed trees are actually courtesy of viral infections.

Incidence: Phomopsis Gall on Willow & Forsythia



Phomopsis gall (fungal pathogen) may look like an alien invasion of trees and shrubs, but it's hardly a disease problem that is going to ruin a landscape. Damage is usually isolated.

Incidence/Problem: Anthracnose



Fungal Pathogen

Anthracnose is very common when spring weather is cool and moist, rare when it is warmer and/or dry. It looks bad, but rarely causes a problem unless it happens year after year and almost completely defoliates the tree each year.

Definition 9: Problem

- *“Damage or Losses exceed acceptable thresholds”*

Problem: Target Canker on Maple



Fungal Pathogen

Target cankers are a problem for several reasons. First, they attack stressed trees...that's a problem that the trees are stressed. Second, they are perennial cankers, the gifts that keep on taking. Third, there's no control for the fungal causal agent. Fourth, the causal agent is everywhere. Eventually the canker will girdle the tree and kill everything above it.

Problem: Verticillium Wilt



Fungal Pathogen

Verticillium wilt has such a wide host range and can cause immediate death due to the blocked vascular tissues (those that move water/nutrients), slow death, or minimal damage. Also, like the target canker fungi (*Nectria*, *Eutypella*), *Verticillium* is a ubiquitous, soil-born fungus.

Problem: BOB (Bur Oak Blight)

- Fungal Foliar Disease (Leaf Spot)
- *Tubakia* species
- Bur Oak Specific

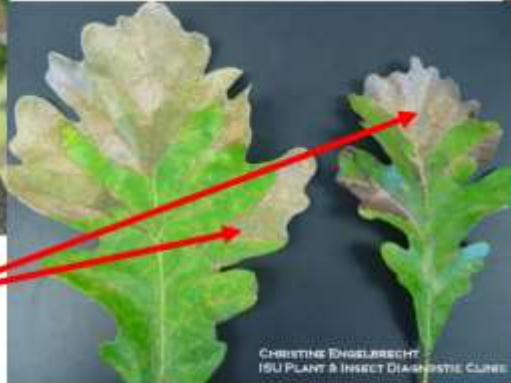


What about BOB? That's a problem for bur oak lovers in Minnesota. It's a recently identified fungal (*Tubakia*) disease infecting bur oaks in Minnesota, one of our most common native trees. So its host range is geographically huge and significant and the disease can potentially kill the tree. At the very least, it would be considered as a primary predisposing agent.

1. What Does it Look Like?



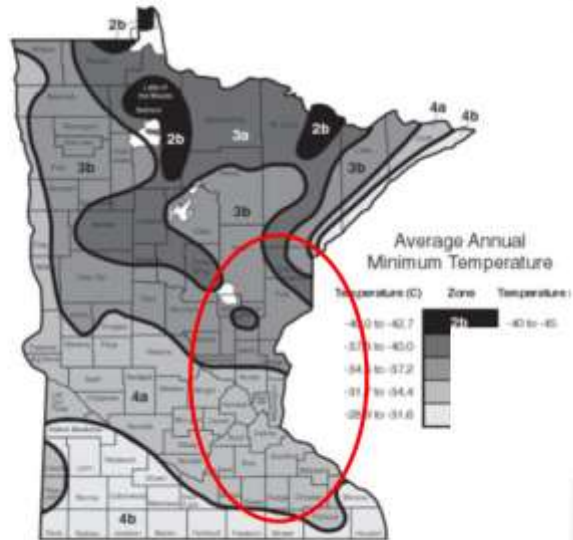
Note "wedge-shaped" symptomology



The fungus has a semi-unique foliar symptomology, that looks similar to drought stress or other problems.

2. Is It In Minnesota?

- Yes



Yes, it's in Minnesota and it's only a matter of time before it's identified in every region of Minnesota.

3. What Trees Are Affected?

- Only Bur Oak...to date



To date, it's only been identified as a disease of bur oak (*Quercus macrocarpa*), which is often described as the “monarch of Minnesota.”

4. How Does It Spread?



4. How Does It Spread?

- Spores from infected leaf blades and petioles
- Spring infection



The spores are on the infected leaves and petioles right now (late autumn). Those leaves tend to hang on all winter and into the spring when the spores are available for a new infection.

5. Recognizable Symptoms?

- Summer (July >) leaf spotting and blotching
- Leaves turn brown/gray
- Worse at bottom of crown and interior
- Many leaves retained through winter
- Worsens each year



Again, the symptomology is only semi-unique, which makes it even more bothersome, more difficult to correctly diagnose if fresh symptoms aren't submitted to the University of Minnesota's Plant Disease Clinic.

6. Can Anything Be Done?

- Maintain Health: Water Management, Mulch
- Chemical Injections: Propiconazole



Keep the trees healthy when possible, especially avoiding drought stress. The same chemical that is used to control oak wilt (propiconazole) has shown efficacy in controlling this disease.

Problem: Emerald Ash Borer



Similar to bur oak blight, emerald ash borer (EAB) is considered a problem because there are so many ash trees in Minnesota, over 900 million in forests and boulevards. It is a killer, though, a sure killer if nothing is done.

How Does EAB Kill Trees?



(This text was provided by Jeff Hahn, UMN entomologist)

1. Trees are killed by destruction of phloem and outer xylem through EAB feeding – phloem conducts carbohydrates – removing it results in girdling and starvation of tree
2. EAB can also disrupt water movement by destroying the outer layer of sapwood where water is moved up the tree
3. Depending on the number of beetles infesting the tree relative to its size, trees die within 1-5 years (typically 2 – 4 years)
4. A few EAB larvae are not going to kill a tree but when you get 100's, then there will be a noticeable decline and eventual death



The damage is caused by the tunneling larvae, not by adult beetle feeding activities. The larvae work under the bark, in the photosynthate-moving phloem tissues right under the bark or within an inch.

Canopy Thins & Dies Back



(These notes were provided by Jeff Hahn, UMN entomologist)

The first symptom of an EAB infested tree is thinning foliage in the top of the canopy. Eventually limbs dieback.

Symptoms Similar to Ash Decline



Ash Decline



Emerald Ash Borer

(These notes were provided by Jeff Hahn, UMN entomologist)

However, thinning foliage/dead branches aren't diagnostic for EAB. There are a variety of other factors that can also cause these symptoms

Symptoms Not Always Present



(These notes were provided by Jeff Hahn, UMN entomologist)

Perfectly healthy looking ash can actually be infested. A tree on the St. Paul campus that had trapped two EAB on a purple trap was removed. Despite looking healthy, numerous 1 year galleries were discovered

D-shaped exit holes



(These notes were provided by Jeff Hahn, UMN entomologist)

EAB create a very characteristic 1/8th inch sized D-shaped hole, i.e. flat on one side and rounded on the other side, when they emerge. This is a result of the shape of the insect. The 'D' is always on its side, although it can vary whether the flat side is down or up. While these exit holes are diagnostic they are hard to detect. They typically start in the canopy where they can not be seen. Later, they can be found on the trunk but even then it can be challenging to see. D-shaped exit holes is common for all *Agrilus* species including bronze birch borer and twolined chestnut borer.

Woodpecker Feeding



(These notes were provided by Jeff Hahn, UMN entomologist)

Woodpecker feed on EAB by flaking off bark and feeding on larvae or prepupae underneath. While woodpecker feeding is not diagnostic of EAB, it should raise a red flag and encourage you to examine the affected tree more closely.

Epicormic Branches



(These notes were provided by Jeff Hahn, UMN entomologist)

Epicormic branching occurs when an ash becomes girdled. It can occur at the base of the tree or further up on the trunk. This can be the result of EAB infestations but can also occur from other causes, e.g. ash yellows. Again, this is not diagnostic for EAB but should cause one to look more closely for possible EAB infestation.

Bark Cracking



(These notes were provided by Jeff Hahn, UMN entomologist)

Bark can crack when old galleries develop callus tissue causing the bark to split. Although bark could crack for other reasons, look for larval galleries underneath which would be diagnostic for EAB.

Larval Feeding Galleries



(These notes were provided by Jeff Hahn, UMN entomologist)

When a lot of galleries occur, it is difficult to see individual S-shaped galleries

Treatments:



Insecticide Formulation	Active Ingredient	Application Method	Recommended Timing
<i>Professional Use Products</i>			
Merit® (75WP, 75WSP, 2F)	Imidacloprid	Soil injection or drench	Mid-fall and/or mid- to late spring
Xytect™ (2E, 75WSP)	Imidacloprid	Soil injection or drench	Mid-fall and/or mid- to late spring
IMA-jet®	Imidacloprid	Trunk injection	Early May to mid-June
Imicide®	Imidacloprid	Trunk injection	Early May to mid-June
TREE-age™	Emamectin benzoate	Trunk injection	Early May to mid-June
Inject-A-Cide B®	Bidrin®	Trunk injection	Early May to mid-June
Safari™ (20 SG)	Dinotefuran	Systemic bark spray	Early May to mid-June
Astro®	Permethrin		
Onyx™	Bifenthrin	Preventive bark and foliage cover sprays	2 applications at 4-week intervals; first spray should occur when black locust is blooming (early May in southern Ohio to early June in mid-Michigan)
Tempo®	Cyfluthrin		
Sevin® SL	Carbaryl		
<i>Homeowner Formulation</i>			
Bayer Advanced™ Tree & Shrub Insect Control	Imidacloprid	Soil drench	Mid-fall or mid- to late spring

<http://www.ohioextension.org/extension/2014/04/01/ash-tree-emerald-ash-borer/>

The list from “Insecticide options for protecting ash trees from Emerald Ash Borer.” These are “Hot” chemicals and labels must be followed – Imidicloprid for example is a broad spectrum, contact or systemic insecticide that affects the nervous systems (paralysis). Broad spectrum indicates that all sorts of insects are affected including beneficial insects such as honey bees... Imidicloprid has a good track record. The chemical Emamectin benzoate found in Tree-age (pronounced triage) is very effective and is the only product listed (research proven) with 2 years of protection – possibly 3.



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This presentation is located on our web site, under Gary's Notes.