Plant Problem Diagnosis

Slide 1

Welcome to the WSU Master Gardener Plant Problem Diagnosis training module. We are going to cover a systematic approach to diagnosing plant problems. Learning how to diagnose plant problems is often a challenge; and I know because I am Jenny Glass and I am a diagnostician, and every single day I learn something new about plant problem diagnosing through my work at WSU Puyallup Plant Clinic. The following slide set will show you some of the strategies to help you in your diagnostic pursuits.

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Determining the cause of a problem is essential to knowing how to manage the particular problem, and to know what strategies are likely to be the most effective to manage the problem. For example, you would not apply a fungicide to a turf that had been damaged by drought. An accurate diagnosis of a problem is central to the management of a particular disease or damage. The only way to get there is through the proper diagnosis and some understanding of the biology of pest or pathogen.

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Let me take you through what happens when an unknown comes in. That happens all the time, we get lots of samples where we take a look at them and say “wow, never seen this before and don’t have a clue.” Of course the other thing is occasionally we do get samples like “know this one - can get the answer to the client real quick.” This particular rhododendron came in and it has an unusual growth. It has a gall on the branch, and then what we call “witch's brooming” which is a profusion of buds. My guess is that it is a fungus called “Exobasidium.” A disease pretty common, it causes azalea leaf and flower gall on many azalea varieties. On certain rhododendrons it will cause the leaves to turn white and form a witch’s broom. On this particular sample we don't have any white leaves, we cannot see the fungus directly, we’re going to have to do something else. I have a hypothesis - I think this is Exobasidium - then I need to figure out if I’m correct. The first thing I do is take a look at the literature. I look to see if there is anything described like this - witch’s brooming without the white leaf formation - although you can tell that these leaves are pretty yellow. That’s the first place I step - take a look at the books and see if I can identify it without a whole lot of hard work.

After we’ve looked at various ideas, like I said my idea is that this is probably Exobasidium - a fungus. I'm going to go look for the fungus. I can’t often see the fungus without some aide, so I'm going to use a microscope. So the first thing I do is I look under with the microscope - looking to see if there is any area of a fungus that maybe are worth investigating further on the compound scope. If I see something, I take a piece of tape, or I could actually cut out a part of the leaf, but tape is the quickest. So I often do the quick method first. Put it on the sample, put it on the drop of water, and then move it to the compound scope where I can see 100 times what my eyes can see. I'm looking to see if I can find the identity of the fungus. I happen to know in this case I can’t, because I did the work really hard last week and was not able to. So then what I’m going to do is I’m going to take tissue from the damaged area -
probably some of the leaves, probably the gall here on this particular leaf, and put it on laboratory agar. Wait a week to see if anything grows out.

The third thing I might do, is it’s always good to ask for help. I will probably take some pictures of this particular plant and send them out to various diagnosticians that work with rhododendrons in the country, to see what they might have to suggest for future ideas. Hopefully by doing all that kind of stuff I’ll learn one of two things. One, my hypothesis is correct and I can tell the client how to start managing this. In this case it would be a systemic infection, so this particular plant really needs to be removed and taken out of landscape. Or the other possibility is that I’ll discover that my hypothesis is incorrect and we’ll be able to figure what the true problem is and then I’ll get the client some additional information. So everyday a challenge, everyday an adventure. I hope you have fun doing diagnosis yourself.

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Plant problems fall into two main subsets - damage caused by living or biotic organisms and damaged caused by non-living or abiotic stresses. In each subset there are further divisions of type. Since a particular symptom of damage, for example chlorosis, can be caused by any number of different organisms or stress factors, how is it possible to determine the cause of a particular damage? Well, it’s time to put on your sleuthing hat, pull out your magnifying glass or hand lens and get down to the business of plant problem diagnosis.

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So diagnosis of the problem of this quince plant was quite an adventure. First of all it’s a flowering quince. When you look up literature on flowering quince, you find almost nothing. Typically you find “problem free plant”, or “becomes invasive and is irritating to try to get rid of.” My particular plant, I’ve seen this on many plants in the Puget Sound region, was getting all these dead cankers on it and the blossoms were turning brown and dying back. I was perplexed as to what was going on and really wanted to figure it out. My thought was “well, if I can’t find information on flowering quince, step back one, and figure out what is going wrong in the family.” This happens to be a member of the Rose family, so I started looking at the Rose family for problems, like roses, cherries, apples, other members of that family. Fortunately for the diagnosis of this problem, I also noticed that it was occurring on the blossoms. We’ll pan in on a blossom right over here, now this is an old blossom from last year, but it’s coated with a grey kind of brownish fungus. Under the microscope the fungus was pretty obvious as being brown rot. A very common disease of cherries, apricots and other members of the *Prunus* family such as English Laurel. This is brown rot, we haven’t seen it on Quince except for the last couple years, but it’s getting to be quite a problem.

Now the main point that it comes in through is the blossoms, so you can see the dead blossoms here. I will be watching these new blossoms carefully for signs of infection. The other part of where it comes in is in wounds, on a shrubby little plant like this quince, there are lots of wounds. Some of the commons ones are where two branches cross, you can see here there are two here. Many crossing branches, those points of friction, those points where it’s really hard to dry out, and the fungus can get in and invade. This particular problem is managed most by one, ignoring it. It is not killing the tree by any means, but it certainly doesn’t look good when branches start dying back as the season goes on. Pruning it out
when I can is an important thing. If I wanted to use a protective fungicide to protect the blossoms that would also be appropriate.

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You will need the right tools to accurately diagnose a plant problem. These tools include a thorough background about the plant, its growth, its care, as well as the development of the particular problem. You will also need sufficient and representative sample material. That is damaged tissue that shows the range of symptoms. Reference materials will help you get an idea of what problems are common to a particular plant. Since the insects, mites, fruiting bodies and mycelium, the signs you may be able to observe are quite small magnification is a must. Find a good magnifying glass or hand lens providing at least five times what the unaided eye can see, and practice learning how to use it. I often recommend people practice using the written materials first. It’s much much easier to determine when a small type is in focus, than it is when you’re looking for something like an aphid or spider mite that may crawl off the plant as you’re trying to look for it. I strongly recommend good use of a magnifying glass. A sharp knife can be used to make cuts into woody tissue to determine where the plant tissue is alive and where it is dead.

It is also important to have a very good attitude and a willingness to work in a team. Diagnosis can be a challenge, so you will often find yourself working with others to determine the cause. Or sometimes deciding after lots and lots of hard work that the answer simply is “I don’t know.” If the answer is I don’t know, there are a few things you want to add. You want to tell the person, if you’re helping someone else, what you do know. What the plant is, what you did to try to figure it out; then you say to them “I don’t know what the cause is,” and then you wrap it up by saying “here’s what we can do next.” Maybe it’s come back with a better sample; maybe it’s asking a lot of questions about surrounding plants or what they used in the landscape. Maybe it’s your skills are good but you don’t have a lot of experience in this particular plant. So let’s find another Master Gardener, or specialist, that can help you with that particular plant. So there is always something else you can do to help do diagnosis if the answer is “I don’t know”.

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What makes a good sample? You need plant material representative of the damage. Often insects, mites, and pathogenic disease organisms can be found at the margin between the damage area and the healthy tissue. Make sure when you’re sampling not to just cut off the dead tissue, go into the healthy tissue and cut that off as well. Sometimes it’s a good idea to include root material in the sample as above ground problems often originate down at the roots. We are rarely accurately able to diagnose samples of poor quality: those that are completely dead, very dry, all rotten or slimy. In this particular picture the client first came in with a few inches of a branch of the dying elm tree. After examining the sample and hearing the story, it was thought that the problem was likely Dutch Elm Disease. She was told how to sample better for this problem, and on her second visit to the diagnostic clinic cuts made under the bark of the wood of the tree revealed the vascular discoloration typical of the disease. Make sure the sample is representative and thorough.
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Here is a list of just a bit of the information that might need to be gathered when trying to diagnose a plant problem. What is the age of the plant? What is the plant? How is it planted? Where is it located? What has the weather been like? What’s the soil like? What cultural practices are happening in the landscape? We often ask about the conditions of other plants and the distribution of symptoms on the plant or within the landscape, or the development of the problem with time because these characteristics give us clues as to whether the problem is called by a living organism or a non-living abiotic stress.

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One of the best ways to gain this type of information is to ask questions. What time of year did you notice the problem? Are other plants having the problem? Have you used herbicides near the plant? Try not to make too many assumptions when performing a diagnosis. Instead, ask questions and if the answer isn’t too helpful, continue to try to ask questions to get at better answers.

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Build a good horticulture and diagnostic reference library, as this will allow you know which problems are common on a particular plant. The PNW Plant Disease Insect Management handbooks are helpful. There are compendiums from the APS, or the American Phytopathological Society that you may find useful. WSU produces lots and lots of bulletins. There is lots of good information out there.

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WSU Master Gardener policy dictates that plant problem management recommendations come from WSU-approved sources. Fortunately there are excellent sources that exist, including the diagnostic handbook called Landscape Plant Problems, the Pacific Northwest Management series, including Plant Disease and Insect Management, and lots of online WSU resources.

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Websites on the internet can provide further information. Here are just three of the WSU websites that WSU Master Gardeners might utilize. WSU Hortsense was prepared especially for use by the WSU Master Gardeners and homeowners in Washington state. It provides numerous fact sheets on common landscape problems, with information covering both cultural and if applicable, chemical management options. These recommendations are written for the homeowner and they update almost every year. They are fairly current so this is a very good website to use.

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I strongly believe that anyone working with plant problems should develop a systematic approach to the diagnosis to provide a framework for approaching plant problems. This way, whether the plant is an orchid, a lilac, a Douglas fir, you can get started on the diagnosis. I'm
going to tell you about the method I use and it has four specific steps. I hope you're able to figure out one that will work for you, too. Step 1: Identify the plant and determine the environmental requirements that the plant needs to thrive. So I begin my evaluation of the plant with "What is the plant? What does it need?" and then I start evaluating the health and the damage on the submitted plant.

Step 2: I move into developing a hypothesis about the origin of damage. I try to break this into small step-wise questions. One, is there truly a problem? For example, the loss of needles of conifers like larch trees, which are deciduous conifers, come to mind as something that is often brought in as a problem but is not. The next question I often ask is "Where on the plant is the problem developing?" This one can often be difficult to determine. For example, leaves can be damaged because something is injuring them directly, or damaged because the stems or roots underneath have been injured and thus the plant can no longer support healthy foliar growth. The pattern of damage on the plant or within the landscape will often indicate whether the problem has a living or non-living cause. Finally, I look for symptoms and signs to see if they suggest a particular problem.

Step 3: I try to determine what evidence would be present to indicate my hypothesis is correct or valid. For example, when I'm wondering about spider mites I will check for the presence of spider mites, their eggs or their webbing. When I'm wondering about whether it's a pesticide problem, I'll try to figure out which pesticides have been used on the plant. I may take a sample where I think it's a fungal leaf spotting disease, and I may put the sample in a moist chamber to see if the humidity in a moist chamber will induce sporulation of a specific fungal pathogen. Then the last step is to check for that evidence and evaluate whether the hypothesis is accurate about the cause of the problem, or may need to be reconsidered. This method is not foolproof; it will not always lead to an accurate diagnosis. But it is certainly better than thumbing randomly through books or just taking your best guess.

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First you need determine if a problem even exists. Some samples brought in as problems truly are not. Beneficial or non-pest insects found on plants are commonly submitted as damaging insects. For example, in this picture lady beetle larvae attacking an aphid - what's the problem? It's actually the aphids, not the black lady beetle larvae. Variegation, the yellowing of a plant that's supposed to look that way. Normal conifer needle loss and special features under the leaves such as the nectaries of cherry leaf are a few of the other common non-problems that we often get submitted for diagnosis. In this picture the client wants to get rid of the little black bugs. These little black bugs are the lady beetle larvae; would you get rid of them? No, they're your beneficial; they are helping you get rid of the aphids. Our job is to educate the client that the lady beetle larvae are beneficial, and to assess whether or not the aphid population is seriously damaging the plant or if the lady beetles have it under check.

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We've talked a lot today about scorch. It's a really common problem in Eastern Washington. I'm here with this hemlock. Hemlock is a plant that likes a little bit of shade and in the sun it can easily be scorched. But this gets a little tricky. This, these whiter needles here, are actually not an example of scorch. This is a cultivar that features the new growth being white, and it's ornamental as opposed to a problem. Here we have an example of something that if
someone were to move into a new home and wasn't familiar with this, they might think this was a problem. But in fact this is something you probably pay a lot more for - to get this whitish new growth. As Master Gardeners we’re going to see these samples come in every now and then, that are not actually problems at all, but ornamental features.

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Certain problems can be diagnosed by the symptoms they produce in a plant. Upon close examination of plant symptoms resulting from the damage of living organisms, the sign, for example, the mycelium of a fungus or the presence of an insect pest such as an aphid may be revealed. In this example, rosy apple aphid damage, you need to look within the curled leaves for evidence of the sign of the problem. The aphids or some evidence of their past presence such as cast skins.

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I wish there were a dichotomous key for plant problem diagnosis, or at least a set of questions that must be answered and what those answers will mean. But alas, this is not how plant problem diagnosis works. Instead, you need to get lots of clues to determine the most likely cause to a problem. The pattern of damage or how the symptoms are distributed on the plant, in the landscape, over time, may reveal whether or not the problem is likely to have an abiotic or non-living cause, or is the result of living factors. Master Gardeners need to be keen observers in order to detect these patterns. For example, when investigating the cause of a leaf spot problem, note the characteristics that appear on an individual leaf. What are the shapes of the spots? What are the colors of the spots? Where are they found on the leaf? How many are there? Do they have a border? Then consider where are the affected leaves on a particular branch? Where is the affected branch on a particular plant? Where is the affected in the landscape? How is that plant relative to other surrounding plants, etc?

In general, you want to determine if the pattern has a uniform or regular special distribution on the plant or within the landscape. The more regular or uniform a problem appears, the more likely it is to have a non-living or abiotic cause. Random or irregular distributions on a plant or in a landscape are typical of plant problems with living origins of damage. Check also for associations of the damage. Is the problem on one family of plants? In one area of the landscape? Only on frost-intolerant species? On the plants you felt sorry for in a big sale, or something like that? You are looking for ways to connect the damage in that landscape to the origin of the problem. Sometimes determining when the problem happened, how rapidly it happened, and if there is a start and stop time to the damage will also give you an idea of whether the problem has a living cause or non-living cause. In general, the more rapidly a problem develops the more likely it is to have a non-living stress. And if the problem develops quickly and then stops, doesn't seem to spread, that’s another factor that suggests a non-living stress, as opposed to a spreading insect problem, or a spreading progressing disease issue.

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Regular or uniform damage patterns that are rapid onset as well as no further spread are often indicative of injury from an abiotic or non-living origin. While we were actually unable to determine the exact origin of this particular lawn damage, based on the images and
information submitted, the distinct pattern, the straight lines to the injury all point to a non-living issue. You don’t need to spend time looking for a turf pathogen or turf pest.

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Generalizations about damage from living organisms are that the damage pattern is often randomly distributed on the plant, or within the plants in landscape. Often the problem develops slowly and spreads from the damaged plant or within the planting in the landscape. This fungal disease, fairy ring, showed up gradually in the turf, was scattered about the course and continues to spread under optimal fairy ring growing conditions.

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In both of these lawn damage pictures there are linear or regular patterns suggesting that the cause of the damage is abiotic in origin. In the picture on the left, mechanical injury in the form of compaction from foot traffic on the pathway would be a likely hypothesis as to the origin of damage. The yellow line sneaking across the lawn in the picture to the right is the result of herbicide dripping from a leaking back pack sprayer. When shown this image people often initially guess that there is a hose lying across the grass that causes injury. By looking closely at the damage they soon realize that the grass is not matted down, as would be expected by hose overlaying injuries.

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Sometimes it is necessary to look at the whole landscape or the whole plant population to get sufficient clues to piece together the cause of the problem. In this situation, a hot spot of damage in the marigold planting and the contrasting robust health of the nearby salvia plants, a non-host for this particular problem, gives us the information to lead to the cause of the problem - a soilborne fungus called white mold, caused by the fungus Sclerotinum.

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Checking out some of the damaged marigolds reveals the signs of white mold - white cottony mycelium and its overwintering structure of dark hardened sclerosis. Management of this problem will involve sanitation, removing damaged plant material and the fungal growth within, removing these things from the planting bed, and crop rotation away from the host of the pathogen. You may want to try salvia again, or maybe one of the ornamental glasses, as the host range for this particular pathogen is quite large and includes many of our common landscape bedding plants.

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The leaf damage on this rhododendron has a great deal of uniformity. In general, most of the damaged leaves appear to be showing injuries down the main vein, though a few are at the tips. This pattern is indicative to the cause of the problem. Indicative that the problem is an abiotic or non-living in origin. Gathering a bit more information about the damage - the problem happens midsummer, the rhododendron is located on the south side of the home, and rhododendron leaves typically curl when under stress - quickly leads to the diagnosis of summer sunburn to the leaves.
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The leaf spots on this aloe tree by contrast are quite variable in their distribution and appearance. Several are clustered, there are areas of the leaf unaffected, most but not all of the spots are round, some are between the veins while others grow over the veins. These random patterns point to damage from a living or biotic origin. The circular nature of many of the lesions, the diffuse border to the injury and the fact that the problem develops right over the main veins are all patterns typical of fungal leaf diseases. These leaf spots are typical of the foliar infection of the disease Apple Scab, a fungus infection that also infects flowers and fruit. On the fruit the symptoms give it its common name scab.

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The timing of the problem can also provide clues indicating the nature of a particular type of damage. The injury on these rhododendron leaves is very specific. Occurring only at the tips of the leaves, this clues us in to the likelihood that the damage is abiotic or non-living in origin. Our second clue is that the problem is not getting worse, rather that the damage has a definite start and stop time, as noted by the healthy leaf tips on the newest growth. The injury in this case was caused by a late spring frost. Leaves exposed at time of the frost were damaged, while leaves still in the bud were protected and do not show the injury. This type of leaf distortion could also have been caused by aphid feeding on succulent new growth. But the two clues that suggest abiotic stress is the cause of the problem, suggest that we do not have to spend time trying to decide if there were aphids there or not. Aphids would have been found at random, and would probably be affecting new growth.

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These are Kalmia or mountain laurel, and what we’re seeing here is some scorch, some brown spots on the leaves. This actually can happen over the winter, when the temperatures get too cold the soil freezes. These plants are broadleaf evergreens; their leaves still need water even during the winter. They’re still losing water through the leaves. Once the soil is frozen they can’t replenish the water they’re losing, so they start to desiccate, dry out, just like this. This can be called winter scorch, or frost damage, but this is essentially the problem that happens. You can see just above these leaves there is some nice healthy new growth. It doesn’t do any long term serious damage to the plant. The plant is still healthy and puts on this new growth. Eventually these other leaves may fall off or they may just be covered by the new growth. The damage is just confined to the leaf itself. It is something that we see on a lot of broadleaf evergreens, especially in eastern Washington, which would include rhododendrons, mountain laurels, cherry laurels and some of the others that we see.

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In general the characteristics of living plant problems are: a gradual onset of the problem, and irregular or random distribution of symptoms on the plant and in the landscape, and the problem scope is generally limited to one of a few closely related plant species, and the problem typically spreads or gets worse with time. While abiotic problems often show up quickly, may have a very uniform or regular distribution on the plant or in the landscape, and the same problem may develop on many plants in close geographic proximity to each other, but the problem does not seem to be spreading or getting worse on a given plant. Not all
problems will have these characteristics, and many exceptions to these rules occur. For example, for those of you dealing with deer, you all know about deer browsing. The plants were fine before you forgot to shut the gate to the deer proofing fence around your garden, and by the time you got home from work those tasty tender leaves are gone and so is the deer. And unfortunately, far too often when we are trying to diagnosis a plant problem we are dealing with a column that I’ve left off this particular chart, the “I don’t know, haven’t a clue, didn’t notice” types of answers.

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Also, diagnosis can be complicated by many factors: the complexity of the problem involved, the fact that the stress wasn’t recognized at the time of the event, how the stresses may predispose a plant to attack by insect pests or disease organisms. Oh, and the fact that the plants can’t talk back to tell you their stories also will add to the challenge.

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Several problems are showing up on my sort of neglected roses here. First of all you can see that they have the fungus known as black spot, a very common fungal infection of rose leaves. It causes a black lesion, now that again is the symptom, how the plant is expressing the problem. If we pulled out our hand lens and looked carefully over the surface we might see the sign, the actual fruiting bodies of the fungus. For the most part this is one of the diseases where symptoms alone are enough to diagnose it, because there is not much else that does this other than rose black spot. Lots of the rose leaves have the rose black spot fungus, sanitation would be a very effective management strategy. As you can tell it’s the middle of March here, and I have not pruned this plant back so I need to get on that particular thing. The plant also shows a little bit of insect damage, there is some minor stippling injury but again not worrisome to me. The plant will eventually show very brilliant rose mosaic virus symptoms, and you can see some of the yellowing there. That’s from the presence of the virus in this particular plant. Rose mosaic virus does not hurt the plant other than causing these leaf symptoms and stuff, the flowers are just fine and this particular plant is left in my landscape. I am not worried that the virus is going to harm the plant or spread to other plants in the landscape. Rose mosaic virus does not spread by insects, by pruning, and it doesn’t spread by mechanical touch. Rose mosaic virus though, the symptoms of the virus change as the year goes on. As the spring leaves come out I expect to see very intense viral symptoms, leaves that are produced mid summer probably no symptoms, and the last fall leaves will show the symptoms again.

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If you suspect that an abiotic stress is the origin of damage, try to determine which major category of damage, whether it's mechanical injury to the plant, environmental stresses such as temperature, light, oxygen, water, or adverse chemical influences. Which category is responsible for the observed damage? Check out what the typical symptoms of those problems are, what the environment has thrown at the plant recently, how the plant was planted, what is the fertility and soil type like, and what has been done around the landscape around the plant and you will often get clues to determine which stress is the cause of the problem.
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This is a variety of what we call Western Red Cedar. *Thuja* is the Latin name. What I want to show here is, we’ve been talking about scorch, here on this little leaflet here we have this discoloration right here. This actually isn’t scorch; this is another example of a cultivated variety that includes this special more ornamental. On the tips you do see a little bit of scorch, right here and right here where it’s discolored even further. Plants that have this lighter leaf color are more prone to scorch especially in the late summer when it gets really hot. You can see on this one there is even more scorch, and so probably at one point this was all fairly yellow, fairly light colored, and over time and exposure to a lot of sun it sort of crisped out, for lack of a better word. This is a combination of some of it being the variety, some of it being ornamental, and some of it actually being scorch on the plant.

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When the pattern is suggestive of living organisms, try to determine if the causal agent is likely to be an insect or mite pest, a large herbivore such a deer or bird, or if the injury is induced by infection of one of the pathogen groups. Carefully search symptoms for evidence of the signs of the problem, compare the symptoms observed on the plant to the common causes of plant damage for that species, or compare the problem to your or another Master Gardener’s experiences with that particular type of plant.

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Break Time

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Fungal plant infections are common causes of plant problems encountered by Washington State Master Gardeners in their gardening and diagnostic efforts. The vast number of fungal pathogens, the variety of the diseases they cause, and the many environments that they thrive under make them a common issue in the garden and landscape. Depending on the exact pathogen, fungal infection can take place at the foliage, the flowers, the leaves, the stems, or some combination of these areas. Or actually, even the roots. Some generalizations about fungal infections are that often but not always foliar lesions will be round with diffuse borders. Within the damage spot you may observe concentric rings of damage, or you may even see the fungal fruiting bodies within. These patterns develop due to how the fungi infect and grow in the tissue. Fungal leaf damage to plants can also show up as your regular leaf spots or large portions of the plant blighting back.

Don’t fall into the trap of eliminating fungal infections as the cause of the problem simply because the spots are not round. You will want to check the damaged leaf carefully for evidence of the pathogen, as many signs including mycelial growth or the production of fungal fruiting bodies bearing spores can be observed within the lesion. The picture here of the fungal leaf spot disease of Photinia shows the round shape of the lesions, the red diffuse border around the damage, and the black fruiting bodies of the pathogen growing in the tissue. Don’t be fooled when trying to manage this problem that it is only a leaf spotting disease, because it is not. Upon close examination of the stems it will reveal damage from the
pathogen as well. So your management strategies, for example sanitation, or the use of preventative fungicides, must target both the stems and the leaves.

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Fungal infections of the stem may develop in many ways as well. Some problems develop as cankers or dead areas of the stem. The main branch in this picture has been killed by the fungus *Nectria*, which can be observed as coral-colored fruiting bodies emerging from the dead canker on the stem. Other fungal infections induce blights, where large portions of the stem, the buds, and the foliage on them die back. Still other stem infecting fungi enter into the water-conducting vascular tissue, grow within this water-conducting tissue and inhibit the movement of water, leading to the wilt of an infected plant. Pruning out cankers and blight damage is often effective management strategies for these problems. But typically in the case of a vascular wilt the entire plant must be removed and replaced with a species not within the host range of that particular pathogen.

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In order to investigate root problems you need to dig up the plant. Or be smart and carefully examine the root system at the time of planting in looking for problems. And then plant the plant properly. So basically, root problems often get overlooked. In general, root damage from fungal pathogens result in: the rotting of the root system, the killing off of the fine feeder roots, discoloration and even death of structural roots. Several root diseases have characteristic symptoms such as the cinnamon brown discoloration caused by *Phytophthora* root rot that is pictured in this particular picture.

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This is an example of a fungus affecting, this is Ponderosa pine, or rather it was Ponderosa pine, you can tell that by the longer needles here. What I want to highlight is these knots here, these galls that are growing in the branches. This is Western Pine Gall Rust, and it’s really common all over eastern Washington. Ponderosa pines are one of the few trees that grow really well in our area. They are really drought tolerant, but this is one of the diseases they sometimes get. And if you see a Ponderosa pine, chances are you are going to see one of these knots on it, this one has three right in a row. It’s a fungus that actually can enter through the pores, the lenticels in the bark, and it establishes inside and actually creates this gall that eventually will kill the whole branch. It goes through several different stages; at different times of the year they may look differently. In late winter, sometimes early spring, these will be bright orange. That’s when they are releasing spores, and these orange spores will be blown around to new branches in the forest. They are not usually a serious problem of our trees, at most they will kill a branch here or there. Only if an infestation is really severe would you need to do anything. If you were to do something, it involves pruning the branch out or pruning the fungus out, and that’s really all the control that generally happens.

I wanted to show some galls in different stages of development. We’ve got these ones here, this is an older one. You can see how over time we’ve lost all the bark and it’s fallen out of the tree. But you see that this tissue is very woody and it actually holds up as well as this tissue does over time. This is something that you will probably see, you’ve probably seen out in the forest, again something that wouldn’t kill the tree normally but it is a pest in our forests. Up
here in this tree we see some galls at a different stage in development. You can actually see the white coating as they grow, the old tissue flakes off and reveals what’s underneath. You can see that these branches are, this one is already dead, and up above we see other branches that are in the process of dying. The gall actually destroys the vascular tissue in the branch and causes everything above it on the branch to die. This is a disease that doesn’t only affect Ponderosa pines but also can be seen on other pines in Eastern Washington. Again, it is not one that usually requires control but it is one that spreads a lot and chances are as Master Gardeners you’ll see a sample or 100 samples of this brought in for diagnosis.

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Sometimes you’ve got to look at the whole picture. You can tell here on this particular green they have a little issue in that they have these green ring spots with some dead centers. They’re all over. Just looking here one of the things that you can tell is that this is a symptom for a disease called fairy ring. In order to actually find the fungus that does this damage you’d have to dig up the plants and look down in the thatch layer and look for the actual mycelium—so we can’t see it just by looking. But sometimes it’s really important when you’re trying to do diagnosis of a turf problem to get the whole picture. You can see here by looking all over the turf the random pattern, the fact that not every spot looks the same, the scattering of the spots, some clustering, those kind of random patterns strongly suggest that it’s a living plant problem. Knowing that, looking at the different types of living plant problems, probably a fungus like Basidiomycetes or fairy ring is going to come to mind first. When we do a sample, and we can’t unfortunately cut it up today to show you because this is a research product, but if we were going to actually sample for this, what we’d want to take is we’d want to take the sample from the very margin, the edge of the lesion, because the pathogens are often found growing at that point.

So instead of cutting out maybe a dead center, like for example over here, where a lot of the grass is yellow and dead in there - we probably wouldn’t find the pathogen in there, we probably wouldn’t find the pathogen. Instead we’d probably have to move out the growing edge of the lesion or the spot in order to find the evidence of the pathogen. One fungal problem here, fairy ring, caused by Basidiomycetes fungus. We have another problem here, where again you can really see the growing edge, this is a disease called Fusarium patch, sometimes known as pink snow mold, and it has that pink color to it. You don’t need snow, though. In eastern Washington we do get a lot of gray snow mold and pink snow mold because of snow cover, but we can still get things like pink snow mold here in western Washington because the snow is not actually completely required. The fungus is that pinkish color growing around the margin, and again if you were going to get this diagnosed, the best place to take it from is right there on the edge of the lesion. This is a disease called pink snow mold also known as Microdochium patch, also known as Fusarium patch. Why do we have three names? Probably just to make it confusing, but another fungal infection of turf.

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With experience, many Master Gardeners come to recognize many of the common plant diseases because of their distinct symptoms. For example, the scabby appearance on apple fruit is the result of apple scab infection. This fungus also causes olive drab leaf lesions, chlorosis, and a defoliation of the leaves as well as a blighting of flowers.
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Brown rot, a common pathogen for many members of the Rose family, including *Prunus* species such as cherry, peach, apricot, plum and now commonly found in western Washington on flowering quince, can easily be recognized mid-summer by scattered brown branches throughout the tree or bush. Twigs were girdled when the brown rot infections moved from the flower pedestal to the twig in spring. Check the affected plant next spring for the development of the fungal pathogen *Monilinia*. This pathogen can also infect fruit and if infected fruit, referred to as a mummy, is left on or near the tree. These mummies will serve as the inoculum for infection next spring when the plant is blooming.

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A common problem of Japanese maple in the landscape is the soilborne fungus disease Verticillium wilt. This disease usually infects through the roots and grows and produces toxins in the xylem, inhibiting water movement within the plant. This Japanese maple has symptoms of Verticillium wilt. It leafed out in spring, but over the summer began to die on one side of the tree in a branch by branch manner. To determine if Verticillium wilt was the cause of the problem you must check the vascular tissue for discoloration in the wood. Take a branch approximately half an inch in diameter and make thin cuts under the bark into the branch, looking for an olive greenish black streaking or discoloration of the xylem. These symptoms were found on this tree, and the only practical course of action was to remove the plant from the site and to avoid the use of Verticillium wilt susceptible hosts on the site for years and years to come. Unfortunately the host range of Verticillium wilt is quite large. Our WSU Puyallup Diagnostic Laboratory commonly receives this problem on maples, smoke trees, cherries, tomatoes and eggplant.

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Other fungal infections can be recognized by the signs they produce. For example, this azalea covered with a fungus, powdery mildew, but is showing few other damage symptoms. Powdery mildew is a very common problem in Washington, WSU researcher Dr. Dean Glawe, with the help of many of Washington state’s Master Gardeners, has been surveying the state to determine how many powdery mildew fungi we have. His original literature review caused him to expect about 70 different types of powdery mildews, but in the last couple years he has recovered over 200 different species already. Powdery mildews are fairly host-specific, so the presence of many infected plants in your landscape signals that you have several different fungi, their corresponding hosts, and that the environment in your garden is conducive for the development of this disease. Powdery mildews thrive under high humidity but free water such as rain or irrigation often causes the spores to explode or bust.

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Rhododendron powdery mildew symptoms differ greatly from how the pathogen interacts with azaleas. Ring spots, diffuse yellow spots, brownish patches of the fungus on the underside of the leaf may be observed. Thus this problem can be easily misdiagnosed until you become familiar with the range of symptoms of rhododendron powdery mildew.
In general, rust diseases are easily diagnosed because of the abundant production of colorful powdery spores formed in tiny pustules. Microscopic examination may be necessary to identify the specific rust pathogen. Spore production is sometimes limited to the underside of the leaves, while the top surface may show discolored spots. Many rust spores appear orange to yellow. Yet other rust diseases produce brown to black spores, or even white spores. Most rust diseases are very host-specific and only infect specific plants, and many of the rust diseases need different types of plants, primary and alternate hosts, to complete their life cycle.

Root rot diseases often show up as poorly performing or dying plants that require further diagnostic effort to determine the origin of damage. In landscapes, Phytophthora root rot is commonly found associated with areas of poor drainage or overwatering. We have many different Phytophthora root rots, but the disease progress is generally the same. The pathogen kills off the fine feeder roots of the plant and then progresses to rot the structure roots and may even spread up the root crown and main trunk. A cinnamon brown discoloration to the affected roots is a typical symptom of this problem. So you'll have Phytophthora root rot on things like raspberries, Phytophthora root rot on your arbor vitae hedges, Phytophthora root rot of Port Orchard Cedar, Phytophthora root rot of your strawberries, Phytophthora root rot of your apple and pear trees. The phytophthoras are all different, however, the environment, the poorly drained areas are typically necessary for these problems to occur. Another fungus associated with root rots is the pathogen Armillaria, which is often known as the oak root fungus. Armillaria can be found in newly cleared soil and is transmitted between plants by root contact or by spreading of the shoestring-like rhizomorphs. These rhizomorphs are dark strands of the fungus growing on or just below the soil surface. Symptoms typically include: production of smaller than normal leaves, yellowing of the leaves, dieback of the branches, leaf drop, and even death of the plant. White threadlike masses of fungus referred to as mycelial fans can be found under the bark, near the crown of the infected plant. Honey colored mushrooms may grow near the base of the infected plants in fall. Infected trees may also exhibit a dark black line in the infected area encircling the base of the tree. Diagnostic experience and a microscope are typically necessary to recognize these fungal structures.

Bacteria diseases are another commonly encountered problem in Washington landscapes and gardens. Many bacterial infections work as leaf spots; symptoms include water soaking appearance initially, and it may develop into angular lesions limited by veins. The lesions have a yellow transparent quality to them when the leaves are held up to light, or sometimes there may be a yellow halo around the damaged area. Blighting of blossoms, foliage and stems, and soft rotting of fleshy plant parts are other commonly observed damage patterns of bacterial infections. Several other bacteria most notably Agrobacterium tumefaciens, the cause of crown gall, may induce the plant to grow galls. Rarely will you observe bacterial ooze, or the bacterial sign itself, coming from lesions or cankers. For the diseases in our area, such evidence typically requires microscopic investigation.
Bacterial blight, also known as *Pseudomonas*, these bacterial pathogens can kill buds, cause stem cankers and induce leaf spots. The bacterial pathogen remains alive in the old cankers, in buds and on plant surfaces of infected trees. It may be found on many kinds of plants including weeds and grasses. The bacteria may be systemic or living within the plant. They can be spread by splashing water, windblown rain, irrigation water, insects, infected bud wood and infected nursery stock. Infections through natural openings and wounds occur usually during wet periods especially if the weather is cool and wet. The most abundant symptoms are leaf spots, branch or trunk cankers, branch dieback and sometimes gumming on plants like cherry. But the gumming is not specific to bacterial blight and can be caused by other factors as well.

Numerous woody ornamentals and fruit-producing plants are susceptible to *Pseudomonas*. These include maple, lilac, cherry, plum, Asian pear, peach, blueberry, and raspberry. On lilac, the lilac blight often will end up with like a shepherd’s crooking or a blackening and crooking over or tipping over of the tips of the plants. On the maple picture on the right you will see those angular lesions limited by veins. This reflects how the bacterium moves in the plant. When it gets up to a vein it is often initially limited by the vein so you get those angular lesions. But as you can see on the main veins there, the bacteria have entered the main veins. To have the lesions showing up on the veins does not preclude the fact that it might be a bacterial infection.

Timing is also really important when you’re trying to figure out what kind of plant disease you’re looking at. For example these pears, while not showing any damage right now, they’re just in the early stages of budding out. This particular pear section at the WSU Experiment Station is well known for having a disease called bacterial blight. The important thing here when you’re managing for bacterial blight is: “What tissue does the pathogen arrive in?” and it turns out that the pathogen gets into the plant through the blossoms. So we’ll be watching the blossoms very carefully for the first signs of bacterial blight showing up. As we know, traditionally, these particular trees have had it. If we were going to protect it with a fungicide, a lot of the copper fungicide will also prevent entry by bacteria, we would need to be spraying at the time when the blossoms are opening because that’s the time when it’s vulnerable to that particular disease.

In eastern Washington, fire blight is another bacterial infection Master Gardeners may encounter on their pears, apples, crabapples, and other members of the rose family such as pyracantha or hawthorn. The pathogen *Erwinia* typically attacks via wounds or blossoms. Initially twigs or flowers appear water soaked; infected tissue quickly turns brown to black and dies, appearing scorched. Cankers can develop on twigs and branches, sometimes girdling the limb and causing dieback or even killing the plant. This problem is currently not thought to be problematic in western Washington.
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Crown gall is found on many ornamental plants, fruit trees and caneberries, most commonly on rose, cherry, apple, euonymus, raspberry and blackberry. Crown gall is caused by a soilborne bacterium which infects the tissue through wounds on the crown and roots. Young galls are fleshy, white and large masses on the roots and stems; older galls are dark brown and turn woody or corky in appearance. They range in size from less than an inch to many inches across. The bacteria can be spread from infected to clean soil by water movement or equipment. The damage varies with the location and size of the gall. Small galls are often harmless, but large galls on the plant may weaken or girdle the plant.

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Viruses are submicroscopic in size, which means that they cannot be seen. Or if they are seen you need something like an electron microscope. So we must rely on the symptoms, or how the plant responds to their infection to determine whether or not the plant is infected with a virus. Many times virus infected plants show few to no symptoms so we fail to notice and this infection is a problem. Other times the symptoms are so subtle (oh, the plant grows poorly, it has a pale leaf color) that we attribute the damage to other more likely causes. Then there are the virus diseases that we recognize, the ones that induce bizarre symptoms like ring spots found on this peony or distortion of the leaves. These are readily recognized as viral infection. Leaf and fruit mosaics, stunting of the plant, severe distortion, chlorosis along the vein, and ring spots may be symptoms of virus infection.

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Several viruses affecting tulips are spread by many species of aphids. Flower petals show streaks, stripes, feathering or flames of different colors. Flower size, pollen production and bulb health are affected. Viral symptoms may be easily confused with genetic variegation. Genetic variegation is readily available in commercial varieties and should be used to get these pretty-looking flowers as opposed to letting your plant become infected by one of these viruses. And since they are so easily spread by aphids, the best management for Tulip Break Virus is rouging or removing of the entire infected plant.

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Rose mosaic virus, caused by a complex of viruses, is the most common viral infection of roses. This disease may cause the leaves to show yellow lines, rings, mottled or netted patterns. These symptoms are usually seen in spring on part of the plant or all of the plant and may not be present on leaves produced at other parts of the year. Some infected plants show no symptoms. Rose mosaic viruses are not spread by insects, not spread by pruning tools, but can be spread between plants by grafting or budding. Infected plants may be less vigorous, have fewer flowers, and be more sensitive to winter injury, but in general the damage is very little. So we typically allow rose mosaic virus infected plants in our garden because we don’t worry too much about the spread.

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Nematode damage typically shows up as poorly growing plants. Or you may notice circular
dying patches of plants in a field situation. These symptoms result from the nematode’s feeding damage to the roots. Damaged roots are unable to absorb sufficient water and nutrients for healthy growth. If a nematode-infested root system is pulled up and examined, galls or lesions may be present on the roots. For example, this parsnip root damage is caused by root knot nematode infection. Take care not to confuse beneficial root associations such as nitrogen fixing nodules, or mycorrhizal fungi, with damage from nematode feeding to the roots. Observation of nematode injury is not that common for Master Gardeners. Damage from foliar nematodes, one group of nematodes you may observe, could often be observed. Foliar nematodes can be found on many plants including African violets, ferns, and elderberries. The type of damage you are looking for is wedge-shaped necrotic lesions on the foliage.

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Several plants are specialized to live as plant pathogens. These include mistletoes and dodder vines. Rather than growing with a regular root system, these plants have a specialized haustoria. This haustoria is capable of parasitizing a host plant to obtain water and nutrients. So many of our mistletoes out here are dwarf mistletoes, they are leafless. Dodder, the yellow vine pictured there on the right, is pretty common in warm temperature areas.

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Well one of the problems that we see on Ponderosa pines quite frequently is the parasitic plant called dwarf mistletoe. You can see it right here, clearly not at all like the needles of the pine. This is a plant that actually infests the Ponderosa pine, it’s not a lichen, we referred to that a little earlier, and this actually does the plant harm. What happens is a seed lands somewhere on the branch of the pine and it’s sticky, it sends what’s called a haustoria, into the vascular tissue of the pine. And we might be able to see how it comes right out of the bark like that. It starts deriving its nutrients, stealing nutrients from the pine itself. You can see here it's yellow, it doesn’t produce its own chlorophyll, which is why it steals the nutrients from another plant. Over time this really causes problems for the Ponderosa, especially if the infestation gets bigger. One little piece on one little branch isn’t so much a problem. But if we look over here we see an infestation of mistletoe that’s actually on the trunk of this tree, and that’s even more a problem. And you can see the blue paint that means this tree is slated to be removed. There isn’t a control that we can apply to this; it’s a matter of pruning out the mistletoe when it gets too bad. In this case we’re taking the whole tree because we’ve got this infestation of the main trunk here. You can see a little bit on this one, but we’ll go to another example right here. Over time mistletoe will cause the branch to swell like this and that’s because of all the tissue that’s actually inside the branch. We don’t see it here, but quite frequently you’ll see out in the forest what are called witch’s brooms. That’s where there is a lot of really dense growth in the pine tree that doesn’t look normal, and that’s often caused by this dwarf mistletoe.

It’s really common in eastern Washington, and you can see up here we’ve got even a bit denser growth of it, and even just above our heads you can see a really huge infestation of dwarf mistletoe. Over time this branch would be killed by that, you might sometimes see some of what they call witches broom, that really dense growth, coming out associated with it. But chances are this whole branch is going to die from this point on. And here again you see this branch swelling, the bark is cracking where the mistletoe is. Like I said before, there isn’t
a control, we can't spray it, we can't inject the tree to get rid of it. The only control would be in this case would be to take the branch out probably all the way back to the stem. Or as you can see here, the city has decided because of the blue paint, they're going to take this whole tree to limit its spread. The life cycle of the mistletoe is that over time that it produces a small insignificant white flower and from that it produces a seed, I referred to a sticky seed earlier. When it's time to let the seeds go, it actually ejects the seed, it can travel up to a distance of 150 feet, so it can easily travel from tree to tree and it's just wherever the seed happens to land that the mistletoe takes hold. In forests, foresters actually control mistletoe by taking out whole stands of trees in order to get rid of it. It impacts the value of lumber, and of course it impacts negatively the health of the trees. So this is for that reason an important problem in eastern Washington, it's not one that individual home owners usually do too much with, but it is one for people who own larger property sites, it's one they have to contend with.

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Many Master Gardeners, however, will spend most of their time related to inquiries about parasitic plants assuring their clientele that our lichens, our mosses, and even English ivy are not parasitic. These simply live on another plant but do not gain nutrition from it. English ivy in some locations is becoming a weed due to its invasive nature, but it harms the plant through competition of sheer weight of its growth, not by parasitism.

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Break Time

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When diagnosing insect and mite damage on plants two important things to keep in mind are the feeding habits and the life cycle of the insect or mite pest. Matching the observed damage with a type of mouthpart is necessary to determine the identity to the cause of the problem. Damage caused by pests with chewing mouthparts result in missing tissue, for example, leaf notches, leaf holes, holes in the stem, tunneling, mined buds. Piercing-sucking mouth parts, however, usually result in a chlorotic damage called stippling. Your entomology training will cover this in detail. Details of the pest life cycle will come in handy when trying to find evidence to decide whether or not a hypothesis you've developed about the cause of the damage is accurate. For example at the WSU Puyallup Diagnostic Laboratory we often receive apple maggot damaged apples after the maggot has dropped from the fruit.

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You will likely have no trouble finding chewing insect damage in your garden on which you can practice your diagnostic skills. Notching on the edges of the rhododendron leaf is symptomatic of injury by adult root weevils. These typically feed at night. Other chewers include cutworms, leaf miners, leaf cutting bees. Frass or insect fecal material is often a common sign of such pests.

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Okay, one of the chewing insects of course is the root weevil. There are a couple different species of it but we'll just talk about them in general. Interesting insect in that it has a long
snout on it. At night evidently it comes out and holds onto the leaf edge, and walks backwards, sort of straddles the leaf edge, walks backwards and sort of chews out what we call these notches in the leaf tissue. Root weevils get on a wide variety of hosts, this is on rose but we'll look at it on other species, but what I want you to look at the notching on individual leaves. It's irregular notching because we're going to look at a leaf cutter bee damage later, which isn't irregular at all. Sometimes there'll be one notch on one leaf, and that's evidence of the root weevil feeding. But other times large sections of the leaf are removed or there are several notches in one leaf. Here is an example on this little sort of Solomon Seal plant of the root weevil feeding. And you can tell it's a tough little insect because here it's notching out of this prickly Oregon Grape. And this is how severe it can get. I mean it can get to the point where it consumes most of the leaf itself. So it can be one notch of a leaf or it can be most of the leaf tissue. Here unfortunately is really good root weevil damage. See this notching on the margins of the leaves, irregular, taking out the whole margin really, looks like somebody cut it with those pinking shears.

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Another thing is trying to figure out when to look for the problem, or the cause of the problem. In this particular instance this is probably severe root weevil damage on rhododendron. You can see all the evidence that the pest has been there, the small little notches on the margins of the leaves. And boy was it a hungry one, lots of feeding on this particular plant. But as you can tell from looking here you do not see the insect itself. The reason for that is root weevils are night feeders. So if you really wanted to confirm that this in fact is one of the root weevils causing the damage, you have to come out at night. Take a flashlight and carefully examine the plant, looking for the pest. Now if you do happen to see the pest, one of the great things to do there is to use integrated pest management - squish the pest when you see it and that will be the physical control, or removing the pest from the equation.

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Many insects such as aphids, lacebugs, scale insects, as well as spider mites have a piercing-sucking mouthpart that leaves a chlorotic stippling injury as a result. Left to right the two rhododendron pests shown here are aphid damage and rhododendron lacebugs. Often the pest is no longer on the plant when the damage is noticed but may have left some sign behind, especially cast skins or eggs, to indicate the pest had been present.

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To me it is always amazing how much information is out there about various plant problems if you're willing to do some search. For example this particular plant is a bamboo. There are actually two varieties here. One that has the dry margins around it, then another type of bamboo that does not have the dry margins around it. So you can see all the little speckling on both leaves there, this is bamboo spider mite injury. Now in the summer it's pretty obvious, you flip a piece of white paper under the thing, you hit it a couple of times and the bamboo mites start to skitter all over the place. But what I just learned, and it's very obvious on the underside of the leaf, is that WSU has done quite a bit of research on bamboo spider mites. WSU Vancouver has a couple bulletins on it. You can find them online if you type in to your favorite search engine “bamboo spider mite WSU extension”. What I just learned reading one of these articles is just how exciting sometimes these pests can be. These particular
spider mites are communal, and you can tell because there are areas where they feed and areas where they poop. And isn’t that amazing that little tiny animals like that can live in harmony together. So to me, this particular tidbit of information that I learned by reading a WSU bulletin, go from “Oh it’s just another mite problem” to “cool and awesome mite issue.” Not that it has anything to do with the management of the problem. But then again with bamboo, what’s the management question you’re all going to get? It’s “how do I kill it because it was so cute when it was small but now it’s over ¾ of my yard and I want to kill it.” The answer there, dig fast.

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Sometimes the damage from insects or mites comes from toxins that are in their saliva that induce abnormal plant growth or damage. In this picture, the tiny eriophyid mite called maple bladder gall mite is responsible for the development of the galls in the maple leaf. Other common pests associated with toxic plant affects include fuchsia gall mite, the poplar petiole leaf gall aphid, the balsam woolly adelgid, and the Cooley spruce gall adelgid.

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We’ve been talking about eriophyid mites which are actually not insects, but mites, they have eight legs. In this case it doesn’t matter how many legs they have because they are too small to see with a naked eye. This is a silver maple, and this is what’s called is a bladder gall mite that’s affecting this tree. And you can see pretty clearly all these galls the mites have. They’re a sucking insect, so they come on to the leaf and they stick their sucking mouthpart into the leaf and inject a toxin that causes this gall. The plant actually grows this gall to protect the mite. Early in the spring, these are much more visible because they’re a bright red color and it’s only in the summer that they fade to this green where sometimes we don’t even see them. They are not a serious pest of silver maples, they won’t kill a tree, but they will obviously make it look unhealthy. For these there isn’t usually a control, some people have been worried about the look of the tree, so they’ve treated something, they’ve put something systemically that the tree will take up like a Merit or some sort of insecticide. But really I don’t recommend treating for these, the best control for these is, when they fall off in the fall, make sure you rake up all these leaves and get rid of them. Don’t leave the leaves near the tree, and just get rid of them take them off the property or compost them. Do something to get rid of them completely. Then apply dormant oil in the late winter and that will hopefully suffocate whatever eggs might be remaining in the area.

This is also a good chance for Master Gardeners to help clients determine a threshold level. Sometimes a little bit of damage is acceptable, and just helping them understand that this isn’t going to kill their tree and maybe leaving it alone is an okay response. There will always be clients who want the perfect tree and in that case their threshold level is zero and then we can give them the appropriate controls. But for the most part when I see these when I work with these trees, I just advise the people I’m working with to leave them alone and then get rid of the leaves and it usually controls the infestation, keeps it within acceptable level. What this can mean, that might be more serious, eriophyid mites targeting a tree year after year might indicate that the tree is under some stress, and in fact they’re putting it under some stress when an infestation is this severe, that there are that many mites on a leaf. You can see that here we are at the end of July, this leaf has not reached its full size and that’s because of all the mites on the leaves.
Larger animals including birds, slugs, deer, dogs and rabbits may damage plants. The damage typically results from mechanical injury to the plants from feeding or scratching. For example the holes in this birch were caused by the feeding from sapsuckers, and this deer is browsing on succulent leaves. Salt burn from an animal’s urine contacting plant foliage or roots may also result in plant injury. Lawns as shown in the upper image are often damaged by dog urine.

Well, this here, you can probably tell this is a section of crabapple. This is an ornamental tree that we grow a lot, but you can see here at the end there is a lot of tissue missing. I’m not sure how easy it is to see, but you can tell here, the stems, the petioles of the leaves, that the leaves have just disappeared. That’s because a deer has come and munched on this tree. Deer are very common in eastern Washington; we have a lot of rural areas, a lot of clients who live in rural areas. And deer are one of the largest pests, at least in size if not in damage. They will eat just about anything if they’re hungry enough. But tree like a crabapple with the low hanging branches are just like candy. You can see here that they can do this. They’ll eat herbaceous or woody plants, it just doesn’t matter. Especially in the winter they are prone to eat about anything. If they are hungry enough, I swear they would probably eat rocks if they could get them in their mouths. So this is an example of that.

Here’s another type of deer damage. This is red twig dogwood; the sample is a little old so that’s what’s causing the leaves to wilt. But here you can see right here, and I’ll turn this around, this bark has all been scraped off all up and down the stem. In the fall, actually sometimes up as early as August, the bucks will start scraping their antlers on woody plants, trees and shrubs like this red twig dogwood. They scrape the bark right off, you can see the result - everything from there up dies. The plant lives, it sends some new shoots up from the sides, from below where the damage has occurred. Bucks do a lot of damage by scraping the bark off trees, and they can kill trees even as much as 2 to 3 inches in stem caliper. This is a pretty vigorous shrub so it grows back after a deer has rubbed its antlers on it. But some larger trees are actually killed by this. It’s something to take into account when someone says “well the whole top of my tree just died”. You might have them check the trunk and see if there is some pretty obvious deer damage. You can see here that they’ve kind of ripped it up so it’s a pretty easy-to-diagnose problem, and that’s deer damage that occurs pretty much all over eastern Washington.

Still another kind of damage is induced by the plant itself. We refer to this type of damage as physiological or genetic in origin. There is likely some sort of abiotic stress at the heart of many of these problems, but as yet a definitive cause has not been determined. Some examples of physiological damage include: tissue proliferation at the base of certain varieties of rhododendron, shot holes without insect or disease influence that develop on laurels, fasciations or ribbon-like plant growth including cherry, willow, and maple. Burrknot, a condition where apple branches start growing root initials even though they’re on the branches, is also thought to be a physiological condition stimulated by moisture and low light conditions.
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Well, our whirlwind tour of common causes of landscape and garden plant problems is over. Time to return to wrapping up the diagnostic process. As indicated previously, the key to an accurate diagnosis process is assessing the validity of the hypothesis of damage that you have been developing. So now it’s time to closely check the plant for evidence of the cause of the problem, to go over the background about the plant and its problems looking for clues to identify the issue. Sometimes all the evidence will point to the fact that your hypothesis is right on the mark. Other times you won’t be able to find the evidence you are looking for, as it may be the wrong time of year, or something you don’t have the tools or experience to see or find, but by looking for it nothing that you do find suggests that the hypothesis is incorrect or wrong. And then there will be times that the evidence you’ve collected is contradictory to the hypothesis you’ve developed. And it suggests that it’s time to return to the hypothesis development step.

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Confirmation doesn’t need to be rock solid evidence. You just want to make an effort to check that your hypothesis is more likely to be accurate than it is to be wrong. So some things you could look for: the signs of cause of the problem. You might investigate whether there were any chemicals used in the landscape if you think the damage was similar to chemical injury. A simple moist chamber incubation could be used where you put the sample in a plastic bag containing a moist paper towel and see if anything sporulates. Of course, note in this way that lots of saprophytic non fungi and bacterium will also grow as well. Then we will all have times where it is necessary to consult somebody with a little more expertise about a particular plant or problem.

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Above all, do not try to make the information and the evidence fit the hypothesis you’ve developed. When tackling an unknown or a complicated diagnosis I try to keep in mind this twisting needle problem found on yew.

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A couple years ago sitting in the office just behind us, I was looking somebody’s yew plant that had just come in and I thought to myself “yeah, they have a little problem because the needles were kind of twisty and curved but other than that I mean the plant looked perfectly healthy.” And I looked at this diagnosis, and most of you remember the diagnostic process is one, take a look at the plant and figure out what it is, and what it needs to thrive. Step two, start figuring out a hypothesis about what could be causing the damage, and then step three, figuring out how to confirm that your hypothesis is accurate or not. Well I had looked at these curvy twisty needles and I said to myself, “oh what causes twisty needles?” Obviously, growth regulator herbicides. You know, somebody used weed and feed near the hedge and had done the damage themselves and just didn’t know it. So I called the client up and talked to them about growth regulator herbicides and they said “well I don’t use them...” and I said “are you sure?” And I asked six or seven more questions and every answer was “no, no no, we don’t use growth regulator herbicides in our landscape” and I just thought “well they just don’t know what they did”.

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Well, fortunately before I concluded the sample, I was talking to Ray Maleike, our retired horticulturist. He had got a big smile on his face because I was complaining about how silly homeowners are; they just don’t know what they do in their landscapes. And he said to me, “hey Jenny, why don’t you go look at those yews right outside the window” and I said “why?” and he’s like “oh just go over there and you’ll check it out.” So I went out and I looked at it and lo and behold, the very same problem that the homeowner was complaining about. Oh my gosh, and I knew that we didn’t use herbicides around here so I knew that it couldn’t be growth regulator herbicides. So that was the evidence that I really should’ve listened to the homeowner, and believed him when he said he didn’t use any growth regulator herbicides. So it was back to the drawing board, what else can cause needle distortion on a yew tree? My thought was okay if it’s not herbicides, something else that is growth regulating. And the thing that came up to my mind was a lot of the insects, the mites, their saliva can be toxic to the plant. So I looked for those on the plant, looked at it under my microscope, didn’t find a thing. And I was really perplexed, and I’m like “well doesn’t seem to be aphids, doesn’t seem to be mites, what do I do?” And there are times where you know just looking for any source of information you can find is really helpful. So I went over to Dr. Antonelli, our entomologist’s insect collection, and just started randomly pulling books off the shelf, and flipping through looking to see if they had any yew pages. And I got so lucky because right in the middle of one of the books, the book by Whitney Cranshaw from Colorado State, there was a picture of the Yew. It looked just like this, and I read up the description and it said “this is Taxus bud mite” injury. And I thought “wow, bud mite, where would the mites be, they would be in the buds!” So I took the samples that I’d been looking at, the sample from this tree, cut open the buds, looked under the microscope, and lo and behold, thousands and thousands of little tiny eriophyid mites in the buds. They weren’t present on the needles, they were in the buds. I always sit there and whenever I get perplexed working in my office trying to figure out whether the client is right or not, I always try to look up at this tree, and remind myself that yes indeed, the client can be correct a lot of times, and a lot of times you really do need to, even though you like your initial hypothesis, step back and revaluate and then you’ll be able to come to the accurate answer as to what the cause of the problem is. So good luck with diagnosing and I hope you have these great moments where everything works out for you. Thank you.

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Don’t worry too much if your diagnostic batting average isn’t as high as you would like. The question, “what causes the damage in the plant?” is a big question and answer and one that is complicated by so many factors. These factors include the difficulty of determining where on the plant the problem is actually originating. Deciding if the fungus or insect you’re seeing is a pest or incidental. The small size of many of these pests and pathogens also complicate things, and a lot of times it’s not just one thing. It’s an opportunistic pathogen taking advantage of some sort of stress. So for example, this particular picture, it was a deodar cedar, it was in the landscape, and it lost all of its green needles one day. No, that is not moss under that tree, those are needles. I have never been able to determine the cause of this particular problem. I’ve reexamined it; I’ve talked to the client a couple times. My guess is that the damage was associated with ethylene production as the ethylene gas can stimulate the development of abscission layers on the needle, causing the green needles to fall off. But whether the gas came from some sort of pollution source like an idling car nearby,
a barbeque, was given off by stressed roots, came from some other unknown source, or maybe ethylene doesn’t have any particular bearing on this problem, has remained a mystery. So it’s a big question to ask, what is the problem of the plant?

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All right, well, Oregon grape is a native plant on both sides of the state. It’s pretty hearty, it’s a broadleaf evergreen and it’s one of the few that does really well in eastern Washington. Looking at this you can see that there are a lot of contortions, some twisting of the leaves, you see that right there. And even some of what might be called epinasty right here, with this elongated growth on this leaf. The first time I saw this, my inclination was to call it herbicide damage because it looks very much like herbicide. But in a little closer examination and in talking with some experts, I looked at this midvein here on this Oregon grape, the growth was thicker and there are little lumps, little bumps all along this midvein. That tells me that this isn’t herbicide damage, that this is actually an eriophyid mite. We saw some pear blister mite, or blister mites on mountain ash earlier; this is one that affects Oregon grape. And the mite itself is so small that you can’t see it with a naked eye, the way you know that it has it is just by the damage that it does. Usually eriophyid mites on Oregon grape are found in areas that are closer to wild areas, forest, or in rural areas. It’s not very common in, especially in nursery grown Oregon Grape. This is one that was cut from a wooded area. But it is something that happens occasionally and because it does look like herbicide damage, that’s something that we can mistake it for very easily. Unlike herbicide damage, the control here is not to pour water to it, although that’s not going to hurt an Oregon grape. The control for eriophyid mite is usually just to prune it out. There aren’t really any chemicals that we would use on it mostly because eriophyid mite doesn’t do that much damage that we would need to spray chemicals. So if you do have a client that brings something like this in, that looks like herbicide damage on Oregon grape, check that midvein. Here we can see it again, that midvein, if it’s thickened up like this, if there are little bumps on it then you know that it’s one of these eriophyid mites and all they need to do is prune this out to take care of the problem.

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After attending this training you will be noticing lots of plant damage you never noticed previously. Right now your eyes are open to the possibilities. But don’t worry, this problem-first attitude wears off for most of us, and you can soon get back to enjoying the beauty of your landscape plants. And don’t be discouraged, plant problem diagnosis is something you can be successful at and you can enjoy doing. You have many opportunities to improve your diagnostic skills and I hope that most of your diagnostic work is on the benefit of someone else’s garden, not your own. I will end this diagnostic presentation with pictures of severe sapsucker injury on Ceanothus. I like these pictures because they cause me to reconsider all that I previously believed about sapsucker injury to trees in western Washington. Sapsuckers are small birds related to the woodpecker family. Previously I had believed that sapsuckers didn’t cause a lot of damage, and that the majority of how the damage appeared was related to how the plant reacted to the problem not the type of drilling that the bird did. But as you can tell from these pictures, this is a seriously damaged plant and with some consultations with other experts I learned that truly the bird may attack different plants differently. So I also hope, as a closing thought here that you are just as hungry for information and practice regarding plant problem diagnosis, plant pathology, plant disease management as this bird was for particular poor tree. Have a great day, thanks for listening.
Well, this tree is a *Stewartia pseudocamellia* or Stewartia. It’s a highly ornamental tree, and here in Spokane it’s kind of borderline hearty and this one has been planted for about 8 years. It’s been through much harder winters than it went through last year but from some reason it just didn’t come back the way it has in the past. We see some new growth coming out, but really it’s not the tree that it has been before. As a client would look at this, they would be looking for any sort of clue that they could find to explain why this happened. Something that might come to their attention you can see right here are these little lichens. We’ve had clients come in before that will bring this in and say “well my tree died back I think this is the cause” And really this isn’t the cause, lichens will grow on trees, they are a simbiont plant. And unless they were extraordinarily thick they wouldn’t ever cause any damage. We don’t really see lichen damage in eastern Washington that I’m aware of. Sometimes the answer is, and we have to tell our clients this, “I don’t know what exactly caused the problem.” It could be that it was winter damage, that seems like the likely explanation but it might be something that we just don’t know. And something that we should also take into account with any woody plant, tree or shrub, whatever we see up here in the canopy is only part of the equation. Something else that we can’t see may be going on below ground. So whenever we’re helping a client figure out a problem, it’s always best to ask them a lot of questions about what’s going on with the roots. Has there been some change with the irrigation that’s happened, has there been construction in the area, were there chemicals that have been applied, not necessarily just pesticides but sometimes even de-ice or fertilizer. This is an example of when we really don’t know what happened but by asking our client a lot of questions we might find something else out about the root system that would help us determine the cause. And sometimes we don’t, sometimes the answer is “I just don’t know.”

Many thanks to the WSU community who have worked so hard for plant pathology, insect problem diagnosis and other things, particularly culminating in the efforts of WSU Hortsense and WSU Pestsense. Carrie Foss, Ralph Byther, Art Antonelli are just a few of the names that come to mind. Thank you. Hope you all had fun with this and have a great day.