What's Wrong With My Plant?

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As an agricultural agent (crop advisor) I am called on to provide a quick and accurate diagnosis of many types of plant problems. This is a review of basic diagnostic protocols that I use to help me determine what the problem is and why it may have occurred. I believe that a diagnosis is only as good as what one learns from it. Knowing "why" the problem occurred is important since it helps avoid or manage future problems.

Scouting nurseries and landscapes on a regular basis is the best way to catch problems early. Infestations, infections, and physiological problems can be controlled more effectively and with less environmental impact when caught early. Look for off-color foliage, areas of reduced growth, wilting, leaf damage, and weeping. If there is a problem with the foliage, be sure to check both sides of the leaves. If the problem is in the roots, be able to determine what a good and a bad root looks like on the plant in question.

Identifying the problem is then a matter of reducing optional diagnoses. Three things to remember as notes of caution:

1) A plant under stress is more likely to have problems.
2) Everything is not always as it seems.
3) There are exceptions to every rule.

It is necessary to identify the primary cause of the problem. More often than not, secondary problems will occur and can cause confusion in the diagnosis.

One of the most important resources in diagnosing plant problems is to know growth requirements for plants growing in their natural habitat and how they compare to nursery production conditions. Identify optimal temperature for the tops and the roots of plants, determine if shading is beneficial, and identify the plant's major pest problems. With that and other information, one can develop plant profiles to help with future diagnoses. Build a reference library to help diagnose plant problems (see "References Resources").

Insect adults have six legs, while their immature forms come in many configurations. They fall into two general groups. Those that have chewing mouthparts include caterpillars, beetles, and grubs. Insects that drink with piercing-sucking mouthparts include aphids, scales, and leafhoppers. Diagnostically, if plants are stippled with very small holes the pests are piercing-sucking insects while chewing insects leave irregular holes in leaves, sometimes only leaving the major veins? Look on the undersides of the leaves and on succulent stems to find aphids. Scales are most often on stems. Borers are chewing insects that leave holes in the trunk or stems of trees and a sap exudate is a diagnostic feature of borers.

Some pests fall into the "insect" category but are not true insects. Mites are major plant pests that have eight legs and are actually in the spider family (arachnids). Mite problems are identified by off color foliage. Be sure to look for them on the undersides of the leaves. Tap a branch with leaves onto a white paper and look for the moving dots that are actually mites. Wipe across the page to see telltale red streaking. Slugs and snails are mollusks and chew leaves and may be noticed by their slime trails. Nematodes are also not insects and while there are many beneficial nematodes, there are also some that cause plant problems. They are very small and wormlike. Many times, decreased growth is the first sign of root nematode problems. Foliar nematodes show a characteristic mosaic pattern on the leaves. Microscopes are needed to identify most nematodes.

Over the last 6 years from our southern New Jersey scouting program, mites, aphids, and scales were, by far, the most numerous problems.

Diseases such as *Phytophthora* and *Pythium* infect a wide spectrum of plants but many diseases are related to limited genera or species of plants. The most prevalent disease infections on nursery crops are the result of the water molds *Phytophthora* and *Pythium*. A cinnamon browning of the wood characteristically identifies *Phytophthora*. *Pythium* can be a primary or a secondary disease and is characterized on roots by easy removal of the outer portion of roots while the cortex remains intact.

On nursery plant material, fungal infections are most common. When leaf spot problems occur, they are generally related to environmental conditions conducive to infection (periods of leaf wetness). One of the physical characteristics of leaf diseases is the pattern of infection typified by regular or irregular rings where the center has browned out or dropped out. Cankers, characterized by sunken stem lesions, seem to be related to environmental and mechanical stresses. It is important to determine the primary infector since environmental factors are usually conducive to secondary infection and treatment may not be the same.

Bacterial disease infections, while not seen as frequently as fungal infections, can quickly devastate plants. Typically bacterial diseases have a water-soaked appearance that looks a bit like the plants are melting. Later on, bacterially infected areas may appear blackened. Rusts are another class of plant problems that are easier to diagnose since they look "rusty." There are two significant types of mildew diseases. Remember that only the powdery mildew is a true fungus while downy mildew is a water mold so chemical controls will not be the same.

Critters also have the ability to cause significant damage. In our area the major problems come from deer, voles, and rabbits. It is sometimes difficult to attribute decreased growth to a pest problem when there are not distinct symptoms. The test used to identify the cause of the reduced growth for a grower who complained that crops did not perform as well as in the "old days" entailed protecting some plants with fencing and comparing the protected growth against unprotected growth. Deer damage was the problem.

Voles are more likely to attack the roots of plants, and damage isn't typically noticed until the tops die back. I viewed a case in New Hampshire where voles chewed the bark of young apple trees causing a spiral damage pattern that corresponded to the area that was exposed as the spiral tree protectors expanded. In that case, there was snow cover that allowed the voles to damage the trees without notice by the grower.

Rabbits are also chewers. They tend to go after plants and trickle irrigation systems. Rabbits and other small animals are also prime targets for dogs. When chasing animals through the nursery, dogs have the potential to cause what might be considered "secondary" damage to the plant population.

Physiological damage, much of the time, results in damage that is not presented in a fashion that sets it apart from other problems. Damage to plants may mimic diseases and/or result in secondary infections. A number of environmental conditions can lead to plant damage. Cold temperatures can result in frost, freezing, or chilling damage; high temperatures may result in desiccation and wilting; excessive light can result in leaf scorch; dry air can lead to desiccation and wilting, and especially on new growth when coupled with hot/bright/low humidity conditions can lead to almost instant leaf scorch.

More damage occurs in a shorter time period when environmental conditions combine. Radiational cooling on clear nights combined with low humidity conditions can result in foliar damage to sensitive plants, even at above freezing temperatures. As a result of warm temperatures and high humidity, plant leaves in overwintering structures can accumulate water (infiltration). When infiltrated leaves freeze, damage occurs. One needs to anticipate weather conditions and their effect on plants to reduce problems.

Experience, especially of others, is the best teacher. Keep a journal of plant problems, diagnoses and pictures of the problems. Keep notes about when and where it occurred, weather conditions leading up to and at the time of and the problem, temperatures, temperature extremes, light conditions, relative humidity, rainfall information, wind conditions, and any other environmental or situational conditions that made an impact. Make special note of any stresses the plant may have sustained leading up to the damage: water deficiencies or excesses, fertility issues, chemical applications, and mechanical damage. Remember that sequential stresses cause cumulative effects.

My abbreviated version of a checklist to help serve as a guide in the diagnostic process includes:

- When did the problem start?
- Did the affected plants get suddenly or progressively worse?
- What kinds of plants are being affected? Is there more than one species?
- Are most plants, a group of plants, or random plants damaged?
- Are the plants growing in conditions similar to native habitat: is the sunlight excessive or limited; is the soil too dry or too wet; or does the pH maximize the opportunity for plant growth?
- What parts of the plant show damage: leaves, branches, stems, crown, or roots?
- How is the damage characterized?
    - Is there evidence of insect activity or disease?
    - Is there browning of the roots? Does the whole root ball show damage or is it in a section of the ball? Is the browning only at the tips of the roots or into the heavier roots? Does the browning slide off when pulled leaving the cortex intact (*Pythium*)? Is the wood stained brown (*Phytophthora*)?
    - How does the plant appear? Is it chlorotic or dull in color? Are the leaves speckled or patterned? Are all the leaves affected or just certain ones?
- Were there environmental conditions that could have impacted the plant?

Problems that look like something else are the ones that may take additional detective work to diagnose. A mottled leaf may be a fungal disease, a virus infection, foliar nematodes, or even chemical toxicity. The process of elimination helps to lead to a solution. To identify foliar nematodes place cut up leaves in a shallow dish with water and check with a microscope in a few hours. If the diagnosis is indicating a disease problem, it may be necessary to collect and submit samples for analysis. Chemical toxicities are more complex. Is the problem as a result of an airborne, spray, or soil source? If the plant is not killed, they usually grow out of airborne and spray toxicities. The outcome from soil contaminants is highly rate-dependent.

The field tool kit that I use for most plant diagnoses includes the following items: a pocket knife including a sharp blade for checking vascular tissue and scissors for cutting and examining buds; bypass pruners for a clean cross cut of stems; a nursery spade to look for root problems; a pruning saw for when the wood gets too big to handle with pruners; a pad of white paper used for notes and identification of insects and mites; a hand lens (10X): sometimes it's better to get a closer look; a digital camera with a close-up option; a soluble salts meter and a pH meter or test strips; a thermometer used mostly for media temperature measurement; and polyethylene zip lock bags for samples and moist chamber use.

Diagnosing plant problems starts with asking questions about the event. Never assume anything; an inaccurate assumption is an easy trap to fall into. Consider asking a question that comes at the problem from a different angle so misinterpreted or misunderstood questions might be clarified.

Take a good look at the physical appearance of the plant and its environment. Attempt to determine when the problem started. In many cases, the start of the problem occurs well before it was first identified. Attempt to relate environmental events that might have had a part in the problem. Remember that the environment is not just the weather but also the physical location of the plant. Was puddled water splashed onto a crop that caused an outbreak of *Phytophthora*? Was there a dry period during a critical stage of growth that caused a rhododendron to wilt enough so when it regrew there was a "crook" in the shoot? Was there a period when the temperature spiked under clear skies and low relative humidity that may have caused a leaf scorch?

Look for ***key indicators*** to help narrow diagnostic options. Was browning of the leaves a clear brown that is usually typical of physiological damage or did it have patterns that might be associated with disease? Was the problem confined to a particular species or selection? Did the problem extend throughout the nursery, in various locations within the nursery, or was it sporadic? Did the leaves on the interior of the plant look better or worse than those on the exterior? How do the roots look in comparison to the tops of the plants? Was the damage or infection on the top of the leaf, the bottom of the leaf, or both sides? Did a neighbor harvest a crop next door that resulted in an insect pest migrating into your nursery stock?

Reduce options for a diagnosis. When the problem can be categorized into an insect, disease or physiological problem, the road to a diagnosis becomes a little easier. If a disease sample is delivered to a diagnostic laboratory, be sure to include both dying and good tissue. The culture needs to be taken from the area of active infection and that is at the interface between the two. Knowing what insects attack which plants is of immense value when there is evidence of insect injury. Use reference books to help identify insects and symptoms of the damage they cause.

When a problem arises that doesn't fit the profile of a disease or an insect, it may very well be a physiological problem but there are exceptions. Insects sometimes arrive, damage, and depart before injury symptoms show up (e.g., leafhoppers). When the tentative diagnosis leads to a physiological problem, confirmation is sometimes difficult. Physiological problems typically arise from the interaction of environmental and cultural components. A few physiological problems and resolution of the issues follow:

Example 1.

Plant: Several species, container grown.

Physical appearance: Plants were off color and growth had stopped.

Key indicators: Roots were burned. The nursery was focused on water conservation and used water sensors to schedule irrigation cycles. The problem occurred several weeks into a period of no natural rainfall.

Diagnosis: Elevated levels of soluble salts causing root damage. An initial pour through test did not show elevated salt levels. A sequential pour through test resulted in measurement of medium fractions. Results indicated the highest level of soluble salts in the middle fractions. The top and the bottom of the container had low salt levels caused by irrigation pushing salts only part way through the container. Irrigation also leached the bottom of the container.

Recommendation: Be sure to include regular leach cycles when rainfall is limited.

Example 2.

Plant: *Tsuga canadensis*: hemlock, field grown.

Physical appearance: Plants were generally off color with needles dying back from the tip.

Key indicators: Needle browning exhibited sequential dieback with banding across the needles. Roots were good. The damage was not progressive. Interior needles showed far less damage than those on the outside. Damage was more prevalent where the plants were exposed (without other plants nearby).

Diagnosis: Scorch from a combination of droughty conditions, high heat, low humidity, and wind. Hemlocks are more adapted to cooler temperatures, higher humidity, and partial shade.

Recommendation: Those plants that were not too seriously damaged will generate new needles as older needles drop. If possible, irrigate to keep foliage moist under these stress conditions.

Example 3.

Plant: *Vinca minor*: periwinkle, propagated.

Physical appearance: Rooted *Vinca* cuttings were transplanted into cells in the late fall. Plants were chlorotic and failed to make much progress over 2+ months.

Key indicators: Roots had not grown out into the medium. There was very little or no top growth. Most of the crop was affected. Few plants had actually died.

Diagnosis: pH (4.3) threshold effect.

Recommendation: Treat with pelletized dolomitic lime (very fine mesh size particles).

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