Sometimes Diagnosis Is Simple

While it's always preferable to have diseases professionally identified in a lab, there are some basic guidelines to help growers diagnose their plants' issues.

Gray mold
(Botrytis cinerea)
Gray, brown dusty spores any part of the plant

White mold
(*Sclerotinia sp.*)
Black mouse droppings, white fans of mycelia, edge of damage. Check around the edge dead spots and in the center of crowns.

Anthracnose
Pincushion (such as Colletotrichum and Phyllosticta) pepper grains in rings (upper surface)

Fusarium
Pink to orange spore clusters (any side) on leaves and stems.

By A.R. Chase

Throughout my more than 30 years as a plant pathologist, I have been asked many times to talk or write about diagnosing diseases. This is always challenging and often rather frustrating. The most recent request was made for the February 2009 SAF Pest Management Conference in San Jose, Calif. I decided to try to discuss only things that a grower could expect to diagnose, including several diseases and definitions of important symptoms characteristics. Because diagnosis is so visual, we decided to use pictures more than writing.

Table 1. Characteristics of the most common and easily diagnosed diseases.

Myrothecium
Black spore clusters with a white fringe in rings (undersides)

Powdery mildew
(such as Oidium and Erysiphe)
White colonies (upper surface) and any plant part, purplish mottling

Downy mildew
(such as Peronospora)
White or purple down on undersides, yellow blotches between veins, burning

Rust
(such as Puccinia)
Brown, orange and yellow pustules (undersides) scattered or in rings

Table 1 (continued). *Characteristics of the most common and easily diagnosed diseases.*

Characteristic	Phytotoxicity	Fungi	Bacteria
Water-soaked (A)	No	Rare	Yes
Color (B)	Tan/white	Tan/brown/black	Brown/black
Colorful margins (C)	No	Yes	No
Disintegration (D)	No	Rare	Yes
Between veins (E)	No	No (except downy mildew)	Yes
Edges (F)	Sometimes	No	Yes
One size (G)	Yes	No	No
Concentric rings (H)	No	Yes	No (except Erwinia)
Sharp margins (I)	Yes	Sometimes	Sometimes

Table 2. *Characteristics of phytotoxicity, fungal and bacterial spots. (Photos on page 49.)*

Diagnose by Sight

There are several common and important diseases that can be diagnosed by the naked eye or with a magnifier of some type, including gray mold (Botrytis), white mold (Sclerotinia), anthracnose (Colletotrichum and Phyllosticta, to name just a couple), Fusarium, Myrothecium, powdery mildew (Erysiphe, Oidium and Sphaerotheca), downy mildew (Bremia, Peronospora and Plasmopara) and rust (Phragmidium, Puccinia and Uromyces). Table 1 summarizes the specific characteristics of each disease. The diseases that can be easily identified are those that make fungal structures like spores that form in mass under normal growing conditions. The types of disease are only those caused by certain foliar fungi. Neither root nor bacterial diseases can be identified by sight alone; while you may get an idea about the cause of a structure like a gall, you cannot be sure of the cause without isolating the pathogen in a lab. Root diseases all look very similar, and the prevalence of mixed infections is common and will only be obvious with a lab identification or failure to achieve control.

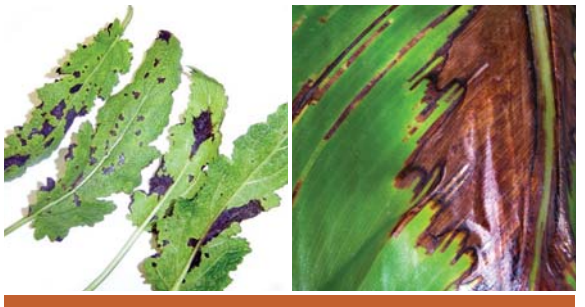
It is also critical to be able to determine whether the foliar damage you are seeing might be due to a phytotoxic response or a pathogen like a fungus or bacterium. Table 2 summarizes the "typical" characteristics of each problem.

A. Water-soaked (left) or dry (right)

B. Tan/white (left) or brown/black

C. Red, purple or yellow margins

D. Spots or disintegrated stems

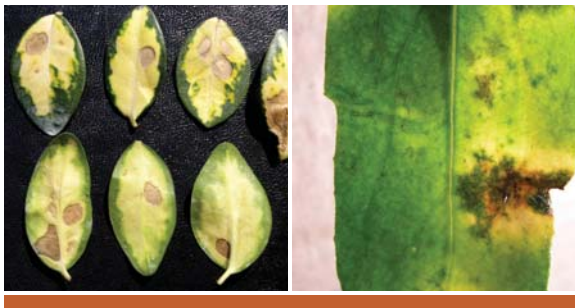


E. Spots confined between veins

F. Spots start on leaf edges

G. Spots of different sizes

H. Spots with concentric rings (left) or not



I. Sharp (left) or irregular margins

Table 2. *Characteristics of phytotoxicity, fungal and bacterial spots. (Letters correspond to table 2 on page 48.)*

If you can narrow down the possibilities, you can avoid prolonging the damage or choosing an inappropriate control strategy. To do this, you must understand the descriptions of symptom types.

Be Careful!

Remember: There are exceptions to these generalizations. If you can narrow down the possibilities, you can avoid prolonging the damage or choosing an inappropriate control strategy. To do this, you must understand the descriptions of symptom types. The specific characteristics I look for include whether the spots are water-soaked (more common for bacteria), the color of the spot itself and whether it has a colorful margin (unlikely for phytotoxicity) and if the spot shows disintegration (common with Erwinia). I also check for the shape of the spot (between veins) if the spots start on the leaf edges. Both are more common for bacterial pathogens than fungal pathogens. The formation of various-size spots in the centers of leaves indicates a fungal disease is more likely than bacterial or phytotoxicity. If the spots have sharp or discrete margins or concentric rings (target or bull's-eye), that also tells me something about their possible causes. Phytotoxicity spots often have sharp edges while fungal diseases may have diffuse margins. It is also far more likely for a spot that has concentric rings to be caused by a fungus than a bacterium or phytotoxicity since only the fungi respond to light and dark cycles with growth rings.

Be cautious with your diagnoses and remember that mistakes cost quite a bit in lost time, use of expensive — and perhaps inappropriate — fungicides and the potential for phytotoxicity. It is always better to obtain a diagnosis from a professional lab than to guess. GPN

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WHAT'S WRONG WITH THIS PLANT?

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The most critical step in finding out what is wrong with your plant is to know that something is wrong with your plant. That means you must be familiar with the normal growth of the crop. This seems like it would be one of the easiest things for an experienced grower to do but in our world of ever changing crop mixes you may see many new plants you have never seen before. Knowing when one of these is not performing up to par can be a real challenge. If possible you should obtain a picture of the crop showing normal growth characteristics as well as normal crop times. New crop or familiar you can watch for the symptoms listed below as indicators of a disease (Table 1).

Table 1. Some symptoms of disease in ornamentals.

Root Disease	Stem Disease	Leaf Disease
Lower leaves are yellow	Lower leaves are yellow	Distortion
Leaves drop	Stem bases are mushy	Leaves drop
Plants are stunted	Plants fall over	Small size
Plant growth is irregular and uneven (some are small and others are normal size)	Cankers or sunken areas near base	Spots
Roots are sparse		Mottled color
Roots are brown to black		
Roots disintegrate		

Once you have noticed that a crop has a problem you must start the detective process known as diagnosis. The most important distinction to make is whether the disease is caused by a pathogen (biotic) or an environmental (abiotic) factor. When I attended graduate school in the late 1970's at the University of California at Riverside the convention was to define disease as only those conditions caused by biotic organisms primarily including bacteria, fungi and viruses. The "diseases" caused by nutritional or environmental factors were relegated to another discipline – namely plant physiology. This distinction is not meaningful for diagnosticians whether they are growers or trained plant pathologists.

When typical symptoms of a disease or signs of the pathogen are present, it is fairly easy for an experienced person to determine not only whether the disease is caused by a pathogen or an environmental factor but also by which one. Comparing the symptoms with those shown in "identification" books containing full color pictures in addition to books or articles that report the known diseases and their causes can often help identify the cause of the disease. Unfortunately, many diseases cause a variety of symptoms and it can be confusing to identify them by picture comparisons alone. In most cases, a detailed

examination of the symptoms and an inquiry into other factors such as culture of the plant, crop history and recent weather conditions are necessary.

Checklist of preliminary facts

- ✓ Recent environmental conditions
- ✓ Recent treatments
- ✓ Common diseases of your plants
- ✓ Time of year

The first thing to do is to rule out the possibility that the symptom is caused by a recent environmental condition (cold, heat, drought, wind or rain) or treatment (pruning, fertilization, pesticide application, irrigation). It is surprising how often we forget this step. Making the connection between an unusual environmental event or a cultural treatment and a damaged crop is critical. If you can rule out this possibility then you can move to the next step which is to know what diseases are common on your crop. Knowing that impatiens can be attacked by Impatiens Necrotic Spot Virus, Pseudomonas leaf spot and Alternaria leaf spot can save a lot of time in determining the cause of a particular leaf spot. Start of list of common diseases of your crops or buy a pertinent reference book. Our diagnositic lab routinely includes a color photograph of your specific sample with each diagnosis to act as a future reference guide.

Additionally, you should keep records of when specific diseases occur on the crop. If this has happened before you should be able to check on a calendar to know when to expect it each year. It is important to limit the long list of possible problems to the few that might be the culprit. For instance, Botrytis blight usually occurs in the winter or anytime when conditions are cool, wet and dark.

Checklist of secondary facts

- ✓ Where are the symptomatic plants?
- ✓ Where are the symptoms on the plants?
- ✓ Where are the symptoms on the leaves?

The secondary facts that can help in a diagnosis include where the symptomatic plants are located in your greenhouse or field. Are they near water, near new construction or near a road? This can lead you to the realization that the environment in that area may be the cause of the problem. Are the symptoms near the fans or near the pads in a greenhouse? For instance a virus that is vectored by an insect may appear near doors first. Where are the symptoms on the plant? If they are on shoot tips, bottom leaves or all over the plant. Some diseases only attack new leaves while others specialize in attacking older or senescent leaves. Finally what does the damage look like on the leaves? Do they form on edges or tips? Are they confined between veins or scattered all over the leaves? The answers to these and other questions can allow you to determine whether the problem is caused by a biotic or abiotic factor.

Fungal Structures

The first thing I like to check for is the presence of fungal structures. These include:

- ✓ Gray mold
- ✓ Powdery mildew
- ✓ Downy mildew
- ✓ Rust
- ✓ Anthracnose

Botrytis blight or leaf spot is often accompanied by gray to brown masses of spores. They look the same on all of the crops I have seen attacked by this pathogen. In contrast, powdery mildew appears anywhere on leaves, flowers and stems as a white, frosty patch of fungal growth. Downy mildew sporulation is usually found on the undersides of leaves and can be lavender, purple or white. Rust pustules also usually form on undersides of leaves (and sometimes stems) and can be off white, tan, yellow, orange or dark brown. Finally, the anthracnose fungi (*Glomerella, Colletotrichum, Gloeosporium, Phyllosticta* and *Phoma*) often form fruiting bodies like black pepper grains in the dead areas of spots on the upper leaf surface.

If there are not fruiting bodies then you should examine the spots for key characteristics tat may be present. Abiotic causes like pesticide phytotoxicity tend to have different characteristics than those caused by fungi and bacteria. Table 2 lists some of the characteristics that can be used to separate one group of problems from the other.

Table 2. Typical characteristics of abiotic and biotic diseases.

Characteristic	Abiotic (phytotoxicity, nutrition and environment)	Biotic (fungal and bacterial)
Texture	Dry, papery	May have wet or moist margins
Color	White or tan	Dark brown or black
Spot size	Uniform	Variable
Leaves affected	Can be all leaves	Often only one age leaf
Speed to develop	Can be in a single day	Over a period of time from days to weeks

If the spot appears to be caused by a biotic factor then you can differentiate between those caused by bacteria and fungi with another short list of typical characteristics (Table 3).

Table 3. Typical characteristics of fungal and bacterial diseases.

Characteristic	Fungal disease	Bacterial disease
Shape	Round, elliptical and grow across veins	Irregular, can be angular (between veins)
Water-soaked	Usually dry	Often wet
Location	Anywhere on leaf	Often on edges
Colored margins	Often yellow, red or purple	Rare
Fruiting bodies	Often present	No
Target spots	Concentric rings common	Unusual

Conclusions

Even after nearly 30 years as a plant pathologist specializing in diagnosis and control of ornamental diseases I rely on culturing the pathogen in many cases. I have been wrong enough times with a preliminary diagnosis that I usually follow-up with a lab work. The other thing to keep in mind is that mixed infections are more common than a single pathogen causing the disease. This is especially true for root diseases but can be common in leaf diseases as well. Once you have a diagnosis you can choose an effective control strategy. Remember that the most effective control is not based on a single approach. Relying on fungicides or bactericides may be successful many times but it will never be as good as including cultural methods in your control strategy.