Chapter 20

Diagnosing Plant Problems

Learning Objectives

1. Identify the skills necessary to begin to function as a plant problem diagnostician
2. State the similarities and differences between diagnosing problems by sample, by fieldwork, by e-mail and by telephone
3. State the process of formulating a diagnosis
4. State the importance and methods of gathering information about plant problems
5. Use reference material, laboratories and other forms of assistance in confirming a diagnosis
Diagnosing Plant Problems

Diagnostics is the process of gathering information about a plant problem and determining the cause. Only when the cause has been determined is it possible to recommend a solution or remedy. Because nearly every plant in our gardens and landscapes will one day have problems, successful Master Gardeners need to develop diagnostic skills that will enable them to stop current or reoccurring problems and to prevent new problems from occurring.

Good plant problem diagnosticians are hard to find. Becoming a good plant problem diagnostician involves the desire to help others, the desire to learn and the patience to develop the necessary skills. Diagnosing plant problems will be challenging, exciting and often fun. The satisfaction of helping other gardeners with your diagnostic work is highly rewarding.

Diagnosing plant problems can involve considerable “detective work”. Sometimes, as a Master Gardener, you will have insufficient information. Other times, the primary cause of a problem is hidden by other, more obvious, but less important problems. Success at diagnosing plant problems will be determined by how much is known about the host plant, how much is known about plant problems in general, the ability to obtain information from the client and the ability to put it all together.

Following are the basics steps in reaching a diagnosis:

▪ Identify the plant
▪ Examine the plant and carefully note symptoms and signs as well as the plant and surrounding environment
▪ Use prior knowledge, reference books and observations to gather information on the plant
▪ Formulate a tentative diagnosis. This will help focus the examination of the plant and assist in collecting relevant information
▪ Attempt to confirm tentative diagnosis with supporting evidence. If there is no evidence to support your initial diagnosis, return to step two. Either seek missed evidence or form an alternative diagnosis. It is possible to have a plant with multiple problems
▪ Seek expert assistance. Sometimes additional laboratory work will be needed to confirm your diagnosis

Examples of Initial Diagnosing

If you postulate that a borer is the cause of a wilting shoot, then cut into the shoot to see if tunneling, sawdust-like frass or the insect is present. If you hypothesize that a potted plant is off color and wilting from root rot, gently remove the plant from the pot and examine the roots.

Basic Skills of a Plant Diagnostician

As a Master Gardener, it is important to know a few basic things about the plant before solving a plant problem. It is important to know the identity of the plant, a little about how it grows, a little about its culture and a little about some of the common problems affecting it.

Basic Plant Science

Every year Extension agents receive inquiries from concerned gardeners: “What are these weird corky ridges on the sweet gum twigs?” (They are normal bark for this tree). “My fern has rust pustules erupting from the leaves!” (These are reproduction spores, perfectly normal). “My white pine suddenly has many needles turning orange/brown and dropping off!” (If this happens in September-October, and only involves previous season needles, it is normal fall needle drop. At other times of the year or if current season needles are involved, it is a serious symptom). Knowing the answers to these questions comes with experience. If asked for help, remember to compliment the concerned person on their powers of observation while reassuring them that the condition is normal.
Figure 1. Pictures of Plants with Disease/Pest Problems

A. Insect galls on leaves

B. Fairy ring in turf

C. Ants on peonies

D. Chlorotic hollyhock

E. Leafminer on columbine

F. Brown patch on turf

G. Slime mold on turf
Plant Identification

The first step to diagnosing a plant problem is to identify the host plant. The better the plant identification skills, the faster the diagnoses and the more confidence the client will have. Most references on plant pests and diseases are organized by plant, so knowing the plant is the essential first step in using many reference books. Nevertheless, there are books that will help identify a plant by its traits.

Plant Morphology and Physiology

Plant morphology is the study of the form and structure of plants. This includes the shape and arrangement of leaves and stems, the form and arrangement of roots, and the structure of the vascular system, which serves as the plant’s plumbing. An understanding of a plant’s structure provides clues to determining the cause the problem. For example, leaves wilt when they do not have enough water; roots take in water and the water moves through vascular systems in stems, petioles etc. to reach the leaf. Therefore, wilted leaves could be caused by something that disrupts water movement: dry soil, disease or mechanical damage to the root system, or damage to the vascular system from a wilt disease or an insect borer. Familiarity with plant morphology helps guide where to look for symptoms.

Plant physiology is the study of how plant systems work. This includes: photosynthesis, the process that a plant uses to manufacture food; respiration, the process that plants use to turn their food into energy; transpiration, water vapor lost from plant leaves; and translocation, movement of water and dissolved minerals from the roots to the leaves and movement of sugars from the leaves downward through the plant.

One does not have to become an expert in plant morphology and physiology to help other gardeners with plant problems. A basic understanding of a plant’s structure and function will increase ones ability to diagnose plant problems and provide insight into why plants have problems. For example, trees and shrubs that are transplanted in mid-summer are likely to fail to establish. This is because the plant loses more water through transpiration in hot weather and the reduced root system may be unable to provide enough water, resulting in wilted and scorched leaves. These damaged leaves will have less tissue for photosynthesis, so the plant will be less able to store food for growth next season.

Basic Horticulture

Improper care for a plant results in many plant problems. In order to diagnose such problems, a Master Gardener should understand basic plant care. The best plant diagnosticians usually have experience in growing plants.
The life of a cultivated plant is divided into three stages: the beginning stage, which involves some propagation process; the establishment stage, which involves a planting or transplanting process; and the maintenance stage, which involves the care received after establishment. Each of these stages involves certain techniques and procedures. The more these techniques and procedures are understood, the better the diagnostic ability. For example, a maple tree may be dying because of poor planting, over-fertilization or under-watering. The ability to determine whether the tree was cared for properly depends on knowledge of tree planting procedures and fertilization techniques for maple trees.

Knowledge of Common Plant Pests

When a plant dies, or fails to grow properly, the first assumption made by the average gardener is that a disease or insect is the cause. The more that is known about the common insect, mite and disease problems of horticultural plants, the faster the diagnoses can be made. Often people think there is a pest when the condition is actually normal or a cultural problem.

Insect and Mite Pests

There are many different insects and mites that damage plants. It may be difficult to become familiar with all of these, but it is possible to recognize the various types of damage caused by different types of insects and mites. Table 1 lists common types of damage caused by insects and mites.

If the type of damage is recognized and the identity of the host plant is known, the pest involved can usually be identified by using reference books. If the client provides an insect or mite sample, the identification of the specimen will lead to information on its status as a pest. Not all insects found associated with plant injury are the cause. Some may be beneficial insects feeding on the pest.

Other Animal Pests

Sometimes animals other than insects and mites affect our plants. Some common examples include deer eating the bark off of trees, mice feeding on plant roots, moles severing roots, birds pecking holes in trees or eating vegetable seedlings, and dogs and cats marking their territory by spraying urine on objects and plants. Animal damage is often especially difficult to control when the animal is a family pet or a protected migratory bird. For more information on animal pests and their control, please see Chapter 24, Backyard Wildlife Management.

Knowledge of Plant Diseases

To be a good diagnostician, it is essential to learn as much as possible about common plant diseases. A good starting point to gain a working knowledge of the common symptoms and signs produced by plant diseases. A disease
symptom is a change in the appearance or growth of the plant. Wilting, galls, leaf spots, blights and root rots are all disease symptoms. A disease sign is the actual disease causing pathogen or its parts. The mildew seen on a plant affected by the disease powdery mildew is a sign of the disease. This is because the white “mildew” is made of spores and mycelium that are visible fungal structures.

If the symptoms are recognized and the host plant is identified, various reference materials can be used to make, or at least, narrow down a diagnosis. Signs must be present on a sample sent for a laboratory confirmation of the diagnosis. When examining a plant sample, all symptoms and signs should be noted.

**Ability to Use Reference Books and Online Sources**

All the areas discussed above constitute a large knowledge base, too much to commit to memory; therefore, one of the strengths of a good plant diagnostician is knowing where to look for more information. Experience diagnosing plant problems is one of the most valuable resources to a diagnostician. Therefore, as a Master Gardener, it is essential to become familiar with reference books, manuals and keys and to use them often.

Additionally, many excellent resources may be found online. There are many reputable websites that are associated with the University of Tennessee Extension office or another regional Extension source. Encourage clients to confirm the diagnosis made from Internet sources with another source.

**The Art of Diagnosis**

The goal of a Master Gardener is to help people, whether it is fellow gardeners or clients. Usually that will involve deciding what is wrong with a plant and how to correct the problem. But how do you look at a piece of branch, or listen to a telephone description of a problem, and then make a diagnosis?

**Diagnosis by Direct Observation**

Sometimes a quick diagnosis can be made of the plant problem by direct observation of the sample, by a photograph or by a clear description of the problem over the telephone.

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**Steps in diagnosing a Plant Problem:**

1. Define the problem by examining growth characteristics and differentiating between abnormal vs. normal changes:
   a. Determine what real problem exists.
   b. Compare healthy vs. unhealthy tissue.
   c. Looks for signs and symptoms of a pathogen.
   d. Examine the entire plant and its community (other plants nearby).

2. Look for patterns.
   a. Non-uniform damage patterns (biotic factors) vs.
   b. Uniform plant damage in a location or specific plant part (abiotic factor).

3. Create a time line for the spread of damage or disease development.
   a. Spread of problem to other plants.
   b. Damage does not occur on other plants or parts of a plant.

4. Determine the cause of the plant damage by asking questions and gathering information.
   a. Differentiate between biotic factors.
      i. pathogens like: fungus vs. bacterial vs. virus
      ii. other animals vs. insects vs. Mite vs.
   b. Differentiate between non-living factors.
      i. Temperature, light, air, water
      ii. Chemical damage
      iii. Mechanical damage

**Diagnosis By Deduction**

In many ways the plant diagnostician is a detective. The plant is examined for clues, questions are asked, references are checked, tests are conducted and finally a diagnosis is made. For example: a client brings in a tomato plant sample. All 10 plants are similarly damaged. They have yellow leaves and stunted growth. There are very few fine feeder roots. Through questioning, it is learned that the grower has applied half of a 20-pound bag of 10-10-10...
fertilizer to a tomato plot that measures 5 by 12 feet or 60 feet squared. This means that the grower put 10 pounds of fertilizer on 60 feet squared, which translates to a rate of 166 pounds per 1000 feet squared. The normal rate for a 10-10-10 fertilizer is 20 pounds per 1000 feet squared. Thus, the fertilization rate was almost 10 times the normal rate, enough to kill off fine feeder roots. Thus, in this situation, the diagnosis is damage to the roots caused by over-fertilization.

**Figure 3. Offering a Plant Diagnosis**

<table>
<thead>
<tr>
<th>Plant Diagnostic Questions:</th>
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<tbody>
<tr>
<td><strong>Trunk/Branches:</strong></td>
</tr>
<tr>
<td>_ bark split</td>
</tr>
<tr>
<td>_ falling bark</td>
</tr>
<tr>
<td>_ sap ooze</td>
</tr>
<tr>
<td>_ sawdust at base or on trunk</td>
</tr>
<tr>
<td><strong>Stems:</strong></td>
</tr>
<tr>
<td>_ split</td>
</tr>
<tr>
<td>_ girdled</td>
</tr>
<tr>
<td>_ swollen</td>
</tr>
<tr>
<td>_ bumps</td>
</tr>
<tr>
<td>_ hollow</td>
</tr>
<tr>
<td><strong>Roots:</strong></td>
</tr>
<tr>
<td>_ white</td>
</tr>
<tr>
<td>_ brown</td>
</tr>
<tr>
<td>_ knots</td>
</tr>
<tr>
<td>_ bound</td>
</tr>
<tr>
<td>5. Do symptoms affect new growth, old growth or both?</td>
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<tr>
<td>6. When was the problem first noticed?</td>
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<tr>
<td>7. When was the last fertilization? And what product or rate? Did it contain herbicide?</td>
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<tr>
<td>8. Were herbicides used nearby recently? What product? Is the sprayer dedicated for herbicide only?</td>
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<tr>
<td>9. Are bees active in the area?</td>
</tr>
<tr>
<td>10. Have insecticides been used recently? What products? How often?</td>
</tr>
<tr>
<td>11. How often is plant watered? Does the soil drain well? Is the plant mulched?</td>
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<tr>
<td>12. Where is the plant located? North, South, East, West side of a structure.</td>
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<td>13. Hours of direct light? Any reflective heat structures (sidewalk, driveway, buildings etc.).</td>
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<tr>
<td>14. Is the plant in a low or wet area of the landscape?</td>
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<tr>
<td>15. Have there been any changes in the landscape (construction, tree removal, damage) in the past 5 years?</td>
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Master Gardeners may find that asking the following questions will help in gathering information for plant disease diagnosis.

1. Client’s name and contact information
2. What the species or variety of plant?
3. How old is the plant? How long has it been planted in its location?
4. What are the symptoms? Describe any additional to those below.

**Leaves:**
- _ falling
- _ cupped
- _ dark spots
- _ distorted
- _ old/new
- _ discolored

**Trunk/Branches:**
- _ bark split
- _ falling bark
- _ sap ooze
- _ sawdust at base or on trunk

**Stems:**
- _ split
- _ girdled
- _ swollen
- _ bumps
- _ hollow

**Roots:**
- _ white
- _ brown
- _ knots
- _ bound
**Diagnosis By Elimination**

Diagnosis by elimination is basically ruling out what the problem is not. For example, when working with a known host plant, a reference book can be used to note the most common problems affecting that plant. Then each of these problems can be confirmed or eliminated by comparing their symptoms to the symptoms on the plant. Usually one of the problem descriptions matches the symptoms of your problem plant. Such a diagnostic method does not seem very professional but it often works.

**Laboratory Back-up**

While there are no plant diagnostic machines, there are various laboratory tests that can help confirm or make a diagnosis. The University of Tennessee has a soil-testing laboratory, a plant tissue analysis laboratory, a plant and pest diagnosis laboratory, and a grain and forage laboratory that samples can be sent. In using these laboratories, it is important to understand exactly what they can, and cannot do. For example, the soil-testing laboratory provides information on the nutritional status of the soil, not on potential insect or disease problems.

Before shipping samples off for diagnosis, every effort should be made to diagnose problems in-house. If it is necessary to use a plant diagnostic laboratory, first check with laboratory personnel to determine the proper type of sample to be submitted for analysis.

**Double Checking the Diagnosis**

Once a diagnosis is made, it should be double-checked by asking other Master Gardeners or Extension personnel for their opinions. It can also be helpful to read through reference books to make sure everything matches. Double-checking is important because prevents rushing through a diagnosis and possibly jumping to the wrong conclusion. Often at a crowded plant clinic, or when there are a lot of phone calls waiting, there is a tendency to try to get through each diagnosis as quickly as possible, and indeed, the mark of an experienced diagnostician is the ability to work through problems quickly. However, an increase in speed is not worth a reduction in accuracy.

**Online Pest Library**

The University of Tennessee provides an online reference library of images that you may direct people to make an initial pest diagnosis. The library is an educational resource available for Extension agents, undergraduate and graduate students, farmers, nursery workers, landscapers, golf course superintendents, pest management professionals and master gardeners.

**Should You Ever Guess?**

There are going to be times when the available information does not lend itself to a satisfactory diagnosis but the client pressures you for an answer. In such cases there is nothing wrong with making an educated guess as long as the client understands that that is what he or she is receiving. On the other hand, if all diagnostic work is hedged with ‘maybe’ and ‘I’m not sure’, credibility will drop. That is why it is important to double-check work, be certain of that work and then, when giving the diagnoses to the client, use language to reflect that certainty.

**Making Recommendations**

Making recommendations depends on a correct diagnosis of the problem. Use caution in recommendations involving the application of pesticides and for problems that have no practical solutions. Extension bulletins generally include control recommendations for common pests, diseases, weeds and cultural problems.

**Pesticides**

There is a general climate today of mistrust and fear about chemical pesticides. Therefore, a pesticide should never be recommended unless it is explicitly listed in a Cooperative Extension Service publication for control of the diagnosed problem. If a pesticide cannot be located that is listed for a particular problem, Extension personnel should be able to help. Pesticides should never be recommended based solely on word of mouth.
Problems Without Solutions
In some situations, no recommendations can be made. There is occasionally an insect, disease or environmental problem that has no satisfactory recommendation. A good example is the problem of moles. We know moles damage the lawn and landscape, but there is not a reliable and practical control. In situations like this, there is often the feeling that it is best to recommend anything in order to give the client something to try. This should never be done. If there is no possible recommendation, say so in the kindest words you can muster. Sympathize, but do not make up answers.

In making recommendations, always strive to teach. It is often quick and easy to recommend something to spray on the plant, or something to add to the soil, but it will benefit the client by discussing cultural practices that might reduce or eliminate the problem in the future. Remember, suggest a course of action; do not to dictate. Also, when possible, give options. For example, if apple scab is diagnosed on a crabapple, the client’s options may be to spray repeatedly with a fungicide, do nothing and live with the problem (apple scab probably won’t kill the tree), or cut the tree down and replace it with a disease resistant plant.

Types of Plant Diagnostic Activities
Extension work will present numerous opportunities to diagnose plant problems. Although the same process is involved in most situations, the emphasis may vary. Telephone calls and plant clinics contribute the most diagnostic opportunities. Telephone and plant clinics are often more challenging for diagnostics than the third method, site visitation. Visiting the location of the plant and inspecting the entire plant will give you more information than looking at a small sample or hearing about a problem over the telephone. A fourth method, distant diagnoses, provides a compromise between site visitation and the others mentioned. Distant diagnoses means diagnosing plant problems from information and images sent via email. Telephone, site visit, plant clinic and distant diagnoses are each discussed in more detail below.

Telephone Diagnosis
In telephone diagnoses, the diagnosis completely depends upon the information provided by the caller. Sometimes, there will be common, familiar problems, such as Japanese beetles or black spot. In these cases, a little information will easily lead to a correct diagnosis. Other times, there will be uncommon, unfamiliar or complex problems. In these situations, it will be very difficult to make a diagnosis over the telephone and a sample will need to be sent in.

Telephone diagnoses are also difficult because many of the descriptive terms we use in ordinary conversation are very subjective and there is often a wide gap between what the caller is saying and what is visualized. When a telephone call results in a lot of uncertainty, it is best to have the client supply a plant sample.

Sometimes, when working on a problem over the phone, you may draw a complete blank. In such cases, it is a good idea to have a written plan of action to follow. This usually takes the form of a list of questions to ask the caller depending on the type of plant involved. Typical questions might include: How old is the plant? When was it planted? Where is the plant located, and when was the problem first noticed? The more information that flows between you and the client, the more likely you will arrive at a successful diagnosis. The art of questioning the caller will develop as you gain experience in diagnosing problems over the telephone.

Site Visit Diagnosis
Success at diagnosing plant problems during site visits depends on a combination of factors. It depends on: knowledge of the plant involved, knowledge of the plant’s basic cultural requirements and knowledge of the potential problems that might affect it. It also depends on the ability to gather information, both through observation of the plant and discussion with the client. With a site visit, there is maximum opportunity to gather information. There are three important parts of a site visit: the site survey, the general plant survey and the detailed plant inspection.
Site Survey
The site survey consists of looking at the area or landscape surrounding the problem plant. This might include checking the exposure (sun or shade), checking the soil conditions, noting the location of the plant (in a field or near a road), observing water drainage patterns within the landscape, etc. During the site survey, check to see whether the plant was planted correctly, whether it is under any environmen-
Diagnostic Equipment

Since many of the insects, mites and symptoms and signs are very small, some means of magnification will be helpful. A hand lens is useful in the field. Microscopes are available in the office. A knife for digging into bark and plant stems is important, as are tools for digging into soil. A pocket notebook and something to write with are essential for taking notes and labeling samples. A Styrofoam® cooler and ice are important in warmer weather to keep samples cool. Although not always necessary, a camera can be an important field diagnostic tool for recording observations. Once the problem is diagnosed, good photographs of field symptoms can be used to teach others. In terms of equipment, it is better to be over prepared than under prepared.

Plant Clinic Diagnosis

Much of a Master Gardener’s diagnostic work will be with plant samples. When hosting a plant clinic, a line of gardeners, samples in hand, will be waiting to talk to the plant clinic experts. Usually the sample will provide the clues necessary to solve the problem. But when the sample only confirms the identification of the plant, you must concentrate on acquiring information to reach a diagnosis. Your job is to learn about the plant’s environment, the care the plant has received and whether the sample is representative of the problem affecting the plant.

Distance Diagnosis

The University of Tennessee Extension now provides an excellent opportunity for diagnosis with a new program called Distance Diagnosis through Digital Imaging System. As monies are available, more and more counties will provide this service as a part of Extension. Distance Diagnosis allows the county Extension offices to submit images to the Plant and Pest Diagnostic Center in Nashville for rapid diagnostics of disease and pests. Distance Diagnosis provides results several days earlier than sending physical specimens via postal mail. In case of an emergency, digital images of plant disease, insect and weed pests can be uploaded to the Distance Diagnosis web page and be diagnosed within one hour. Diagnostic responses will be accessible through the Internet, phone, FAX or email. Distance Diagnosis employs faculty with diverse specializations from across the state to insure that the diagnoses are accurate.

Figure 6. Digital Diagnostic Equipment
### Table 2. Resources and Suggestions for Submitting Soil, Arthropod Pests and Plant Disease Samples for Identification

<table>
<thead>
<tr>
<th>Soil and Soil Nematode Samples</th>
<th>Please see Chapter 3, Soils and Plant Nutrition.</th>
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</thead>
<tbody>
<tr>
<td><strong>Pest Arthropods</strong></td>
<td>• When sending insect samples, try to collect several individuals from the same area.</td>
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<tr>
<td></td>
<td>• Fill out Insect and Plant Disease form (F654) and submit to your county Extension office with a sample.</td>
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<td></td>
<td>• Use a small glass or plastic vial to submerge insects (especially soft-bodied insects) in 70 percent isopropyl (rubbing) alcohol.</td>
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<td></td>
<td>• Do not place moths and butterflies in alcohol. Kill them in a freezer and transfer to a small, crushproof container. A cotton-ball stopper will keep them mold-free.</td>
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<td></td>
<td>• Mites, thrips and scale insects should be sent, as found, on the host plant material.</td>
</tr>
<tr>
<td><strong>Plant Disease Samples</strong></td>
<td>• Fill out Insect and Plant Disease form (F654) and submit to your county Extension office with the sample.</td>
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<tr>
<td></td>
<td>• Never place the specimen form in the same bag as the specimen sample.</td>
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<td></td>
<td>• Send a generous amount of prepared plant material. It should be enclosed in dry paper within a plastic bag. Never add water to a sample unless the plant itself needs to be identified.</td>
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<td></td>
<td>• Do not mix several host-plant species with different problems in the same bag.</td>
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<td></td>
<td>• If you are able to dig up the whole plant, include roots and adjacent soil material.</td>
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<tr>
<td></td>
<td>• If it is not feasible to send the entire plant, send a generous aboveground portion that represents early, moderate and late stages of development. Include at least a pint of soil and a handful of feeder roots.</td>
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<tr>
<td></td>
<td>• For dieback symptoms – dead lesions on twigs that begin at stem tips and increase toward their base – be sure to include healthy portions of tissue below the diseased area.</td>
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<td></td>
<td>• Dead plants are useless for plant identification.</td>
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**Weeds and Plants**

County and state Extension Services lack the personnel and financial resources to accept weed and plant samples for identification. The following information will help preserve plant specimens until such resources become available.

- For weed and plant identification, specimens should include the leaves, stems, roots, flowers and fruits or seedpods if possible.
- A sample of a few leaves can also be pressed flat (a phone book works well) and sent between two index cards.
- If a suitable expert is found or a Master Gardener peer can help, wrap plant roots and stems in a moist paper towel and loosely cover the specimen with a plastic bag.
- Send the sample soon after it is collected – overnight or next-day mail is preferable. Avoid untended weekends. Do not mail samples on Thursdays or Fridays.
- Loosely pack the sample in a padded envelope or box that provides adequate protection.
- Forms that must accompany submissions can be obtained from the local county or downloaded from the web.
Master gardeners work with a wide variety of yard and garden plants including landscape trees and shrubs, flowers, lawns, fruits, vegetables and houseplants. Each of these plant species is unique and therefore, must be approached for diagnosis as such.

**Figure 7. Distance Between Terminal Bud Scale Scars**

Use a Ruler to Measure the Distance Between the Terminal Bud Scale Scars

**Figure 8. Check the Root System**

Check the root system:
(left) Healthy vs.
(right) Unhealthy Root System and Crown

**Woody Landscape Ornaments**

**Measuring Woody Plant Growth**

As with all plants, there is often a delay between the time a problem occurs and the appearance of the symptoms. When evaluating woody plants, evaluate their vigor and look for specific signs and symptoms. A helpful technique for evaluating the condition of a woody plant over a period of time is to measure the distance between terminal bud scale scars. At the end of each growing season, a woody plant forms a terminal bud at the end of the branch. Scales attached to the branch cover this bud. The following year when the bud opens and a new shoot begins to grow, the scales drop off and leave a noticeable scar on the branch. The amount of growth the plant had made during the past several years can be judged by measuring the distance between bud scale scars. Often, a tree that is reported to have ‘suddenly’ died will show that growth has been in decline for several years. A complex of environmental problems, such as drought, compacted soils and attacks from diseases or insects, will often combine to kill a declining plant when one of the factors would not damage a vigorous plant. Additionally, declining plants are more susceptible to pests and diseases that do not attack healthy plants.

**Importance of Roots**

Knowledge of the root system is important in determining the health of a plant. It is usually impossible to examine the roots of woody plants. Nevertheless, always suspect root problems when the entire plant is declining. On newly planted trees and shrubs, it may be possible to dig near the plant to determine the condition of the roots. A major cause of death of newly planted trees and shrubs is a failed root system. When plants fail to establish in older landscapes, the problem is more likely to be nematode or insect damage to the roots.

**Herbaceous Plants**

Annuals and perennials require a different type of diagnostic approach. This is because there is usually more than one plant in the planting. Determining whether the problem is affecting a single plant or a group of plants is useful because it helps distinguish between
cultural or environmental problems, which usually affect many or all of the plants, from infectious disease or insect problems, which initially affect only a small number of plants.

**Observing Roots**
It is usually easy to examine the roots of herbaceous plants, a considerable advantage over working with woody plants. When there is the opportunity to examine the root system of a plant, always dig; do not pull. When plants are pulled up, many of the roots break off and remain in the soil. It is important to know the extent of the root system. The lack of roots can explain failure of the plant to grow. Look for abnormal roots, bumps on the roots and evidence of root rot or chewed roots.

**Interior Plants**
Interior plants represent a special situation in plant diagnostics because they depend on the grower for all their needs. Therefore, it is important to learn how the plant should be cared for, as well as how it is currently being cared for, in order to formulate a correct diagnosis. Additionally, when working with potted plants, it is always advisable to inspect the roots. When dealing with a plant sample or telephone contact, and a root inspection is not possible, be cautious in your diagnosis. Root rot or damage is very commonly the underlying cause of a variety of symptoms seen on leaves and shoots.

Light is another vital factor for interior plants. Interiorscape light levels are nearly always much lower than light provided in plant production, so this is a leading cause of new plant leaf drop. Although inadequate light may not kill plants, it may weaken them and make them more susceptible to other threats, such as root rot from overwatering. Discuss light requirements with the client and try to determine whether too little, or too much, light is part of the problem. Sudden changes in the amount of light can cause foliage to yellow and drop and other serious symptoms.

**Turfgrass**
It is important in working with lawn problems to know the history of the problem: how it first appeared, when it first appeared, the extent of the lawn area affected, and the type of grass involved. Many lawn pests and diseases appear under similar weather conditions in specific turf stands every year, so if you know the kind of turfgrass, you are halfway to a diagnosis. When faced with a lawn in very bad condition, it’s probably best to concentrate on the repair process and the steps that can make the lawn less susceptible to future problems.

**Turf Sample**
If the opportunity arises, have the client bring a turf sample. Tell gardeners to select plugs that measure 3 inches across and at least 6 inches deep. Dead sod is usually worthless from a diagnostic point of view. If a patch of lawn is dying, try to get a sample from the outer edge of the patch. It is in this location that insects or disease organisms are most active and identifiable. If the client indicated that the lawn just died out all over, suspect environmental or cultural problems. Cool season turf will go dormant during drought and warm temperatures, so ask if the lawn is irrigated.

**Interacting With People**
**Teach at Every Opportunity**
The primary responsibility of a Master Gardener is to help people. One of the first things to do when working in a diagnostic situation is to listen. Find out what the real problem is. Often beginning gardeners come to a plant clinic with a single plant problem, but what they actually need is basic gardening advice. For example, instead of spending time on a detailed inspection of a piece of tomato plant, time may be better spend, and clients better served, if methods of growing better tomatoes are discussed. Suggesting a good gardening book could solve many future plant problems. In all situations take the opportunity that diagnostic work invites, and teach.

**Unanswered Questions**
Always be calm and courteous. There will be times when the answer to a problem is not known. Do not get flustered. Admit you are not sure of the diagnosis, but do not apologize; this implies you’ve done something wrong — and you have not. Share reasons the diagnosis is difficult: the sample was too old, too small or the host plant was unusual and not covered in the reference books. Offer to continue working on the problem. If the client becomes upset, he might complain that he wasted his time working with you, stay calm. All diag-
Improving Your Diagnostic Skills

For a beginner, the world of plant problem solving is difficult and somewhat intimidating. As a new Master Gardener, you may sit down at your first plant clinic and not have a clue to the solution of the first ten problems; it feels discouraging but it's not unusual. As each diagnostic encounter passes, you will find you get better. There are a few things you can do to speed your skill development.

Keep Records
Keep a list of the plant problems you work on. In the heat of the plant clinic or phone answering battle this is hard because of time pressure, but take the time to make notes. A diary type listing is best, but if you're not the narrative type just list the date, the host plant, the observable or described symptoms and the diagnosis. If there is time, record the references and page number used, if any, in the diagnosis. Using a portable digital assistant (PDA, smartphone, iPad, etc) in the field and later transforming notes into a digital journal may be worth the trouble. Digital photographs of the site and/or plant along with notes leading to the diagnosis can be added. This will be a great tool for future diagnostic challenges.

Be Observant
The world is full of plant problems. Diseases, insects and environmental conditions affect plants all around us. Only a small fraction of these end up at the plant clinic or get described on the telephone. Every time you take a walk or work in your yard be on the lookout for plant problems or plant phenomenon. Many of the things seen during daily activities will be seen again during Extension diagnostic work. When you tell the client that you have seen this in your garden and then explain what it is and how he should react to it, you are teaching and helping in the most effective way. Never hesitate to bring in samples from your yard or neighborhood to other Master Gardeners or Extension personnel. This type of diagnostic work is without pressure, fun and a great way to learn.

Materials for Plant Clinics

Using Your “Garden Solutions” Pad:

1. Remember Pesticide Recommendation Guidelines: When making recommendations that include the use of pesticides, Tennessee Master Gardeners must follow the current recommendations found in the various publications available from the University of Tennessee Agricultural Extension Service (including TMG Handbook). Use of other pesticide recommendations, chemical or “organic,” is not approved.
2. When making pesticide recommendations, if more than one product is listed as satisfactory, each product should be recommended.
3. Cultural problems and soil additives that are not specifically covered by Extension recommendations and publications should be recommended only after consultation with the county Extension agent or specialist.
4. Questions concerning commercial production of crops and pest management on such crops are always referred to local county Extension personnel.
5. It is O.K. to not know the answer to a question. Ask to call a person back when you find the correct answer.
Summary
Remember that being a good plant problem diagnostician should be about helping others, learning and the persistence to develop needed skills. Diagnosing plant problems will be intellectually stimulating and fun. Helping other gardeners with your diagnostic work can be very gratifying.

Terms to Know
Diagnostics
Distance diagnosis
Plant morphology
Plant physiology
Terminal bud scale scars

Test Your Knowledge
1. What is Diagnostics and how does one become a good diagnostician?
2. What is the first step to diagnosing any plant problem?
3. What type of insect causes damage to tissue under the bark, holes in the bark?
4. Diagnosing by elimination is one strategy for the diagnosing process. What are two others?
5. Outline three common reasons for wilting

Resources
National Audubon Society Field Guides

UT Extension Insect and Pest Control Manual (Homeowner Recommendations ONLY) Timely Articles, Publications, and Fact Sheets visit the Extension Publication Website for more From the Tennessee Master Gardener web site you can access UT publications: mastergardeners.tennessee.edu/
The link below to University of Maryland Extension has an extensive collection of photos to help with diagnosis of plant problems: agnr.umd.edu/users/hgic/
Online Pest Library epftpserver.ag.utk.edu/profiles/ddpp.htm
Oregon Sate Site (created and maintained by Master Gardeners): oregonstate.edu/dept/idplants/
The University of Tennessee Distance Diagnostics epserver.ag.utk.edu/Extension/Distance/Ddiag.html
This is Rutgers Weed Gallery: rce.rutgers.edu/weeds/default.asp
Virginia Tech’s Weed Key: ppws.vt.edu/weedindex.htm
Woody Plant Identification: gardens.ag.utk.edu/ohld220/