Diagnosis of Pest Problems

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The Process

The first step in diagnosing a pest problem is recognizing that a problem exists. To do this, managers must know what healthy plants look like under all conditions. Once a healthy standard has been established, they can spot abnormalities.

The next step is determining the cause. Often, a systematic elimination of possible causes is more helpful than trying to select a single causal factor out of many possibilities.

Determining the cause of a plant abnormality requires a thorough examination of both individual seedlings and the nursery in general. The nursery manager should consider location of the beds within the nursery, along with information on cultural practices such as root pruning, fertilization, and pesticide application in the initial phase of the diagnostic process. It is particularly helpful if the manager can examine both affected and non-affected areas because comparing differences between them may lead to solving the problem.

The pattern of occurrence of symptoms and signs is important in diagnosis. Pockets of affected seedlings with a progression of symptoms from the center outward, for example, may indicate disease or insect infestation that is spreading. Seedling damage in depressions may indicate problems such as chemical buildup, poor drainage, or pests that are favored by poor drainage.

Perhaps the most important part of the evaluation is examining the individual affected seedlings. Look carefully at foliage, stems, and roots of seedlings.

The foliage is the best place to begin the examination because it is the first and most obvious portion of the seedling to show visible effects of abnormal conditions. Most foliage diseases caused by fungi, such as needle blight of conifers, and leaf spot, rust, and anthracnose on hardwoods, are characterized by small, discrete, usually darkened necrotic areas, often with fruiting bodies of the causal fungus developing on the dead tissue. Specialists use these fruiting bodies in identifying the causal agent and prescribing controls.

Some fungi that cause needle spots on conifers, such as *Lophodermium* spp., do not form fruiting bodies until most or all of the infected needle dies. The presence of needle spots on pines on which fruiting bodies never develop may indicate needle infection by stem rusts. Knowing the distribution and hosts of these fungi, which can be learned from information given in this manual, may be helpful in their diagnosis.

Other foliage symptoms, such as general chlorosis and needle tip necrosis on conifers, or large irregular necrotic blotches and marginal necrosis on hardwoods, are more difficult to diagnose because they may be caused by air pollution, unfavorable environmental or soil factors, or root infection.

Insect damage is considerably more obvious, due to the actual presence of the pest or conspicuous damage to the foliage. The foliage may be chewed, yellowed, or otherwise deformed by insect feeding.

If a problem is found on the foliage, proceed to a close examination of seedling stems. Death or discoloration of the distal portion of the seedling or branch, with the remainder of the seedling appearing healthy, is a good indication of fungus, insect, or animal attack on the stem. Infection by pathogenic fungi is characterized by discrete necrotic areas, usually with a sharp line dividing the healthy and infected tissues. Fruiting bodies of the causal fungi are often present. Sun scald or chemical burns may mimic damage by pathogens, but the lesions of the former are often bleached rather than dark. Insect and animal attack are usually readily identifiable by the feeding and gnawing wounds. Seedling tops and branch tips killed by pathogenic fungi are usually brick red, whereas those killed by insect or animal girdling are straw yellow.

Stem galls on pine seedlings are a good indication of stem rust infection. But galls on hardwood seedlings are likely to be caused by insects.

If girdling by pathogenic fungi, insects, or animals occurs low enough on the stem, the entire top of the seedling will die. In these cases it is important to examine such seedlings as soon as they exhibit the first symptoms of chlorosis or wilting, when the root system may still be alive and the possibility of root problems can be more easily excluded.

Death of the entire top of the seedling usually indicates the presence of a root problem. Root-related problems are often the most difficult to diagnose because both abiotic and biotic factors can result in similar symptoms. For example, excessive soil moisture can result in symptoms similar to those from fungus or nematode attack. However, when seedlings exhibit symptoms such as root blackening, lesions, shedding of the root cortex, or roughening of the bark on larger roots in the absence of obvious adverse soil factors, you should suspect fungus or nematode attack. Diagnosis of these problems usually requires laboratory analysis of plant tissue and/or soil because symptoms of most root diseases are similar and the causal agent is usually not evident from routine

examination. The causal agent must be identified before proper control recommendations can be made.

Pest Selection Key

The information included in the Diagnosis section of each pest chapter in this manual is intended to guide the nursery manager or pest specialist to the cause of an observed problem. Isolating the cause can be greatly facilitated by a systematic assessment of the symptoms and signs and other information available for a specific problem. The following Pest Selection Key should help in this regard.

Three kinds of information are needed to use the key:

1. The part of the plant affected—seed or cone, roots, stem, and foliage.
2. The kinds of symptoms and signs observed—chlorosis, dead tops, leaf spots, swelling or galls, etc.
3. The type of host on which the problem occurs—hardwood or conifer.

The numbers following the host designation refer to the chapter in the text where pests that cause the type of damage described in the key can be found. Some pests may affect more than one part of the plant, cause more than one kind of symptom, or occur on both hardwood and conifer seedlings. Some pests or problems can be eliminated by cross referencing the symptoms. For example, for information about a conifer seedling with yellowing foliage (chapters 2, 4, 7, 11, 13-18, 20, 28, 39-43, 46-48, 51, 55, 57, 58) and tip dieback (chapters 3, 9, 12-14, 18, 19, 21, 25, 40, 56, 57), you would consult only the chapters represented in both groups—13, 14, 18, 40, and 57.

Seed or Cone Damage

Hardwood—41, 45, 56
Conifer—27, 41, 45, 56

Root Damage

Root collar dead

Hardwood—40, 41, 50, 56-58
Conifer—7, 16, 18, 19, 28, 41, 42, 50, 56-58

Feeder roots dead or discolored

Hardwood—43, 44, 57
Conifer—42-44, 57

All types of roots dead or missing

Hardwood—34, 40, 41, 56, 58
Conifer—7, 16, 28, 40-42, 56, 58

Some roots missing

Hardwood—44, 53, 56
Conifer—44, 53, 56

Roots enlarged

Hardwood—37, 39, 43, 50,
Conifer—7, 39, 43, 50

Roots stripped

Hardwood—52
Conifer—28, 52

Insect in or on roots

Hardwood—37, 50, 53
Conifer—50, 53

Stem Damage

Swelling (galls)

Hardwood—37, 48
Conifer—5, 8, 24, 48

Bark missing

Hardwood—52, 56, 57

Cut

Hardwood—56
Conifer—56

Sunken areas and/or discoloration

Hardwood—33, 35, 40, 41, 54, 57, 58
Conifer—3, 7, 8, 12, 14, 15, 18, 19, 21, 22, 24, 40-42, 46, 54, 57

Tip dieback

Hardwood—37, 40, 56-58
Conifer—3, 9, 12-14, 18, 19, 21, 25, 40, 56, 57

Insect present in or on stem

Hardwood—37
Conifer—25

Stem deformed

Hardwood—37, 48, 57, 58
Conifer—12, 15, 22, 25, 48, 57, 58

Foliage Damage

Foliage normal color

Part missing

Hardwood—49, 52, 57
Conifer—26, 49, 52, 57

Insect feeding

Hardwood—49, 52
Conifer—26, 49, 52

Insect present

Conifer—26

Foliage discolored

Dwarfed

Hardwood—43, 55, 57, 58
Conifer—3, 16, 43, 55, 57, 58

Spots

Hardwood—29, 30, 32, 33 40, 58
Conifer—1, 4, 6, 10, 11, 117, 40, 58

Defoliation

Hardwood—29-31, 38, 51, 56-58
Conifer—4, 6, 10, 13, 20, 21, 51, 56-58

Part dead

Hardwood—29-33, 36, 40, 41, 43, 55, 57
Conifer—1-7, 10-14, 17-2 40, 41, 43, 55, 57, 58

All dead

Hardwood—29-33, 40, 43, 57, 58
Conifer—1-3, 6, 7, 9-11, 13-20, 23, 33, 39, 40, 42, 43, 57

Deformed

Hardwood—29, 31, 32, 36, 48, 54, 57
Conifer—17, 54, 57, 58

Red/brown

Hardwood—40, 41, 57, 58
Conifer—7, 20, 21, 28, 40-42, 46, 57, 58

Yellow

Hardwood—29-31, 39-41, 43, 47, 48, 51, 55, 57, 58
Conifer—2, 4, 7, 11, 13-18, 20, 28, 39-43, 46-48, 51, 55, 57, 58

Laboratory Analysis of Pest Samples

When the causal agent of seedling damage cannot be identified or when confirmation is desired, collect a representative sample and ship it to a plant diagnostic laboratory. Proper selection, handling, and packaging of samples to be submitted are crucial to correct and timely diagnosis. The following guidelines will be useful in this regard:

1. Select 10 apparently healthy, 10 moderately affected, and 10 severely affected seedlings. Wrap each group of 10 seedlings in moist paper towels or similar wrapping material, label, and place them in a plastic bag.

2. Place a sample of most insects observed on the affected seedlings in vials of alcohol and include them with the seedlings. Mites, scales, aphids, and caterpillars should be sent in alive on some of the infested foliage or stems placed in a plastic bag.

3. Collect soil samples from the affected area and from unaffected portions of the beds. Separate soil samples should be obtained from the seedling root zone. Do not include the top soil crust.

4. Ship the samples in a durable cardboard box or similar container *by the fastest means available.* Seedling samples should be shipped with refrigerant to prevent overheating and development of mold.

If possible, include the following information with each sample:

1. Species.
2. Age.
3. Present nursery production quantity (thousand seedlings).
4. Percent of seedlings affected.
5. Date the symptoms were first observed.
6. Names of other affected species.
7. Pesticides, with dosage rates and application dates.
8. Fertilizers, with dosage rates and application dates.
9. Possible weather problems.
10. Cultural practices recently used, such as root pruning.
11. Fumigation history (fumigant, formulation, dosage, rates, dates, season).

12. Soil type.
13. Soil analysis results (concentrations of macronutrients, and micronutrients, organic matter, and pH.).
14. Signs (fungi or insects) and disease symptoms noted on the foliage, stems, and roots.
15. General development of ecto-mycorrhizal feeder roots.

Laboratory diagnosis of submitted samples is usually rapid but can require several weeks. This is a multistage diagnostic process, with time lapses between stages to allow the fungus pathogen or insect to develop under controlled laboratory conditions.