

# Art and Science of Diagnosing Plant Problems

First Detector Training  
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Photo: Natalie Goldberg, NMSU

# Diagnosis

- The process of determining the cause of an abnormality
- Conclusions are derived from critical evaluation of the plant and the environment
- Requires a blend of good observational skills, science, and experience



# Diagnosis begins with you...

- As a First Detector, the art and science of diagnosis begins with you! 😊
- You should be knowledgeable of your local and regional crops
- You should be aware of:
  - The healthy, normal appearance of the plant
    - The normal growth cycle of the plant from planting to harvest
  - Seasonal growing cycles and weather events that affect plant growth
  - Common pests that are found in your area
- When you see something of concern, your first point of contact is your local county extension agent

# Diagnosing Plant Problems

## Preliminary Considerations

- Proper plant identification is critical
  - Scientific name
  - Common name
  - Cultivar or Variety
- Know the normal, healthy appearance of the plant
- Identify the location (microclimates?)
  - Helps to identify potential diseases, insects and abiotic disorders



Photo: [www.forestfarm.com](http://www.forestfarm.com)

*Elaeagnus pungens*  
Compact Silverberry

# Causal agents

## Biotic – infectious/living

- Fungi
- Bacteria
- Viruses and viroids
- Nematodes
- Phytoplasmas
- Parasitic higher plants
- Insects / arthropods
- Mollusks
- Weeds /invasive plants

## Abiotic – non-living

- Temperature extremes
- Moisture extremes
- Soil problems
- Nutrient deficiency or toxicity
- Wind / Air pollution
- Pesticide toxicity
- Improper cultural practices

# The Plant Disease Triangle



# Accurate diagnosis\* depends on....

- **Early** detection of plant problem – routine examination of the plant
- Examination of **good** (high quality) specimens
- Obtaining accurate information



Photo: Natalie Goldberg, NMSU

\* Simply stated – the better the sample and the information, the better the diagnosis!

# Observation

- Observe the plant and it's surroundings
- Be ***descriptive and specific*** about what you see
- Ask questions! Be persistent!
- Take good, thorough notes
- Take photographs

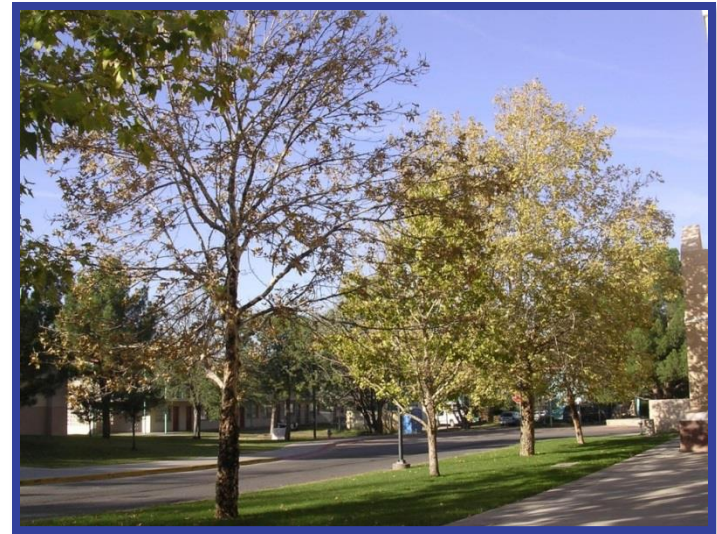


Photo: NMSU-Plant Diagnostic Clinic



# Symptoms

- The visual evidence that there is a problem with the plant
- What part of the plant is affected?
- Obtain good description of symptoms.
- How long has the plant been showing symptoms?
- Are the symptoms spreading?
- Are there other plants in the area showing similar symptoms? Same species or other species?
- Have the symptoms developed suddenly or gradually?



Photos: Natalie Goldberg, NMSU



# Distinguishing between Abiotic Disorders and Plant Diseases

| <b>Abiotic Disorders</b>                 | <b>Plant Diseases</b>                                   |
|--|---|
| May affect several species               | Usually one species affected or like species affected   |
| Symptoms often develop suddenly          | Symptoms usually develop slowly                         |
| Symptoms do not spread                   | Symptoms spread from plant to plant                     |
| Distribution may be uniform or patterned | Distribution is random (scattered, clustered, sporadic) |

# Cultural Practices

- Irrigation: how often, how much, how applied, when applied?
- Fertilization: what used, how much, how often, how applied?
- Pruning practices? Mowing? Aeration?
- Repotting history (for potted plants)?
- Chemical use history? What? When? How?



Photo: Natalie Goldberg, NMSU

# Growing Conditions

- Where is plant being grown?  
Location?
- What is the exposure? Sun?  
Shade?
- Proximity to structures?  
Buildings? Sidewalks?
- What type of soil is being used?
- Any construction (disruption of  
root system) near the plant in the  
past 5 years?
- Any removal or addition of soil  
around plant?



Photo: Joran Viers, NMSU

# Environmental Conditions

- Information on conditions just prior to, and during symptom development:
  - Sunny? Cloudy?
  - Rainy? Humid? Hail?
  - Dry?
  - Windy?
  - Day and night temperature?



Photo: [www.abqjournal.com](http://www.abqjournal.com)

# Sample Quality

- The accuracy a disease diagnosis, insect or weed identification is only as good as the sample and information provided
- Sample must be representative of the symptoms and severity of the problem
- Samples must contain the right plant material
- Samples must be fresh and in good condition
- Rapid delivery to diagnostic clinic may be critical



Photo: Sandra Barraza, NMSU

Samples must contain the right material (margin of infection) or the entire plant or several plants if practical

Diseases may show up on any part of the plant

Foliage symptoms (lesions, blight, scorch, chlorosis, necrosis, etc.



Check for injuries, lesions or cankers on the main stem/trunk

Root problems (rot, lesions, girdling, etc.



# Sample Collection

- Select material showing the symptoms you are concerned about
- Send several samples showing a range of symptoms
- Make sure that the sample contains the margin of disease



Photo: NMSU-PDC

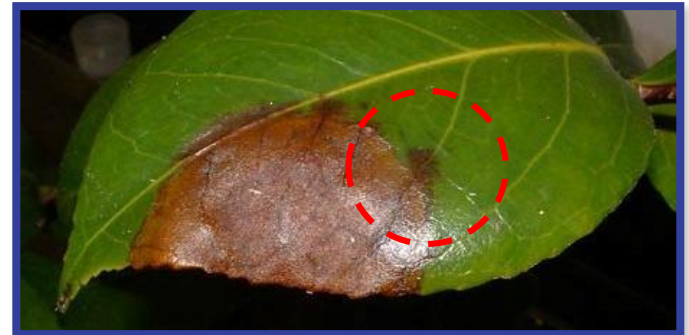


Photo: S. Ashby, Dept. of Environment, Food and Rural Affairs, UK



# Sample Collection

- Send samples of all plant parts including roots whenever possible
- Dig plants out of ground – *do not pull*
- Gently shake excess soil from roots – *do not wash*



Photo: Natalie Goldberg, NMSU



Photo: Gail Ruhl, Purdue University

# Sample Collection

- When the whole plant cannot be collected, select several samples from the part of the plant that shows the margin between diseased and healthy tissue
- For turf:
  - Include at least 1" of soil and roots
  - Select a 3" section of the turf including both healthy and dead grass



Photo: APSnet.org

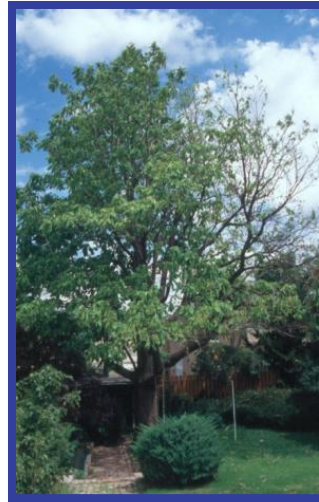


Photo: Natalie Goldberg, NMSU

# Sample Collection

(if you suspect a vascular wilt or canker disease)

- Select samples from branches exhibiting symptoms of chlorosis and/or wilting
- Branches should be  $\frac{1}{4}$  - 1 inch in diameter
- Do not send dead branches



Photos: J. Nickell, Albuquerque Master Gardener



Photo: APSnet.org



Photo: Natalie Goldberg, NMSU

# Dead Plants Tell no Tales



Photo: NPDN



## Avoid dead plants

- Choose specimens which show a range of symptoms: moderate to severe

# Example of Actual Leaf Sample



Photo: Natalie Goldberg, NMSU

# Examples of Actual Turf Samples



Photo: Natalie Goldberg, NMSU

# Examples of Actual Turf Samples



Photo: Natalie Goldberg, NMSU

# Examples of Actual Turf Samples



Photo: Natalie Goldberg, NMSU



# Examples of Actual Turf Samples



Photo: Natalie Goldberg, NMSU

# Packing Plant Specimens

- Keep sample cool prior to mailing
  - Transport in ice chest.
  - Keep refrigerated (not frozen)
- Specimens should be kept moist but not wet
  - Roll in newspaper
  - Wrap in dry paper towel
  - Plastic can be problematic



Photos: Natalie Goldberg, NMSU

Examples of poor packing

# Good Packaging



Photos: Tom Creswell, Purdue University, Bugwood.org



- Plastic bag to keep soil on roots and off foliage
- Dry paper to protect leaves from contact with plastic bag

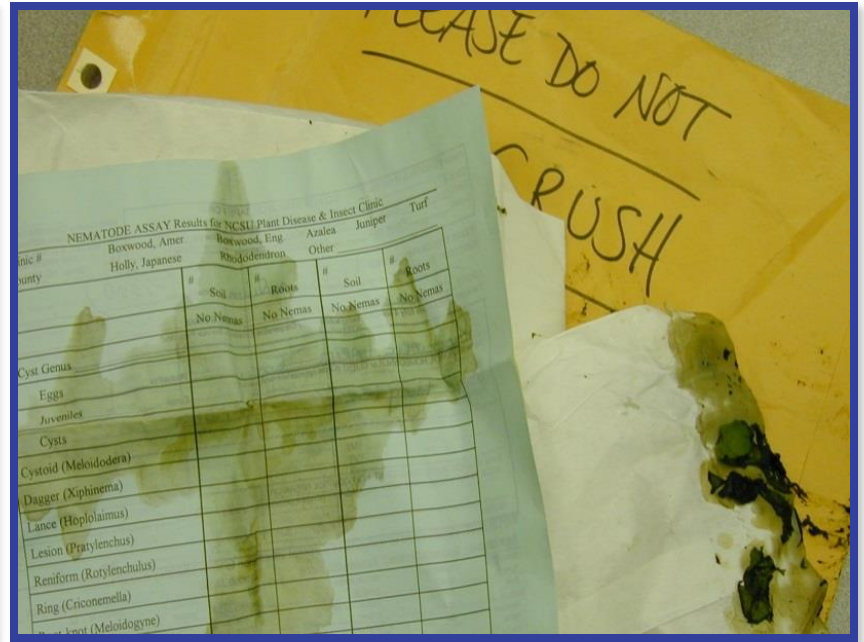
# Packing Plant Specimens

- Pack in sturdy container
  - Box
  - Padded envelope
  - Use newspaper or other packing material to secure sample in box.
- Seal all seams with packing tape



Photo: N. Goldberg, NMSU

# Packing and Shipping Blunders



Photos: Tom Creswell, North Carolina State University

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Photos: Tom Creswell, North Carolina State University



Soil on foliage during shipping creates “diseases” that were not there when the sample was collected

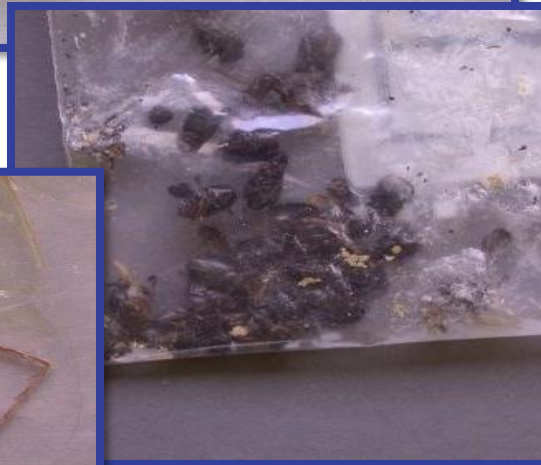
# Packaging and Shipping blunders



- Don't add water or wrap in wet paper towels!

# Sample Submission: Insects

Poor Packaging = Body Parts!



Photos: Lyle Buss, University of Florida

Properly Packaged Mailing Tubes Protect Samples!



Photo: Tom Creswell, North Carolina State University



# Sample Submission: Insects

- Most insects can be preserved in a vial with 70% isopropyl or ethyl alcohol
- Include several individuals and as many life stages as possible



Photo: Scott Bauer, USDA-ARS, Bugwood.org

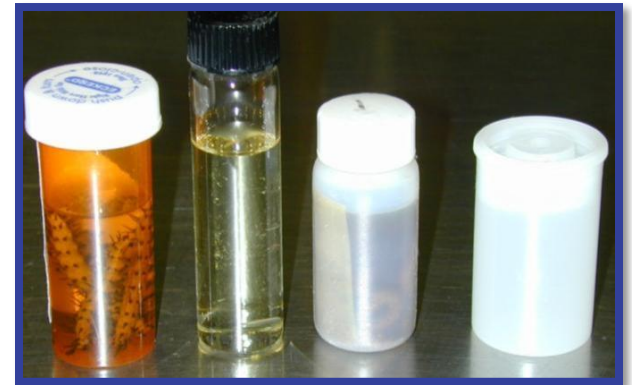


Photo: Tom Creswell, North Carolina State University

# Sample Submission: Insects

- Caterpillars and soft bodied insects should be placed in boiling water for 1 minute prior to preservation (helps preserve color) - **Don't Microwave!**
- Include some caterpillars live in bags of the foliage on which they were found feeding



Photo: Stephanie Sopow, Natural Resources Canada, Bugwood.org



Photo: James B. Hanson, USDA Forest Service, Bugwood.org

# Sample Submission: Insects

- Scale insects, mealybugs and other tiny arthropods may be submitted in plastic bags
- Wrap specimen in dry paper towel before placing in bag



Photos: NPDN



# Sample Submission: Insects

- Collect multiple samples of all available life stages
- May need both males and females to ID
- May need specific life stage to ID
  - Example: Which life stage of whiteflies is used for taxonomic identification?



Photos: NPDN

# Sample Submission: Plants

- Collect intact specimens
- Preserve and package sample properly
- Send suspected exotics in overnight mail



Photos: Florida Department of Agriculture, Division of Plant Industry



# Sample Submission: Plants and Weeds

- If possible, include all parts of the plant:
  - Stems
  - Roots
  - Whole leaves attached to the stem
  - Flowers
  - Fruits
  - Seeds
- If present, collect plants in various stages of growth (seedlings to mature plants).



# Sample Submission (Photos or Digital Images)

- Photos or digital images can be extremely useful for diagnosis
- Think about what you see that the diagnostician may not be able to see
- Good pictures include:
  - Wide angle view of field, landscape or site
  - Mid-range images of damaged areas, whole plants, branches, leaves, webbing, etc
  - Top, bottom and side views
- **Be sure photos are in focus**



Photos: Natalie Goldberg, NMSU

# Examples of Photos or Digital Images Submitted for Diagnosis





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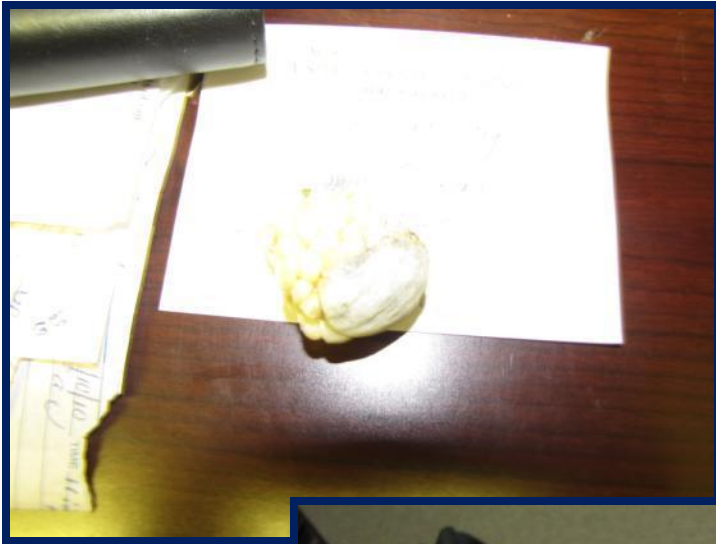
# Examples of Photos or Digital Images Submitted for Diagnosis



# Examples of Photos or Digital Images Submitted for Diagnosis



# Examples of Photos or Digital Images Submitted for Diagnosis



# Examples of Photos or Digital Images Submitted for Diagnosis



# Summary - General Submission Guidelines

- Collect a representative sample of the symptoms and plant parts affected. ***Do not send dry or dead plant material***
- For insects, collect all life stages present
- For plant and weed ID, collect all plant parts and plant in various stages of growth
- Do not wash or add water to samples
- Keep foliage dry and from coming in contact with soil

# Summary - General Submission Guidelines

- Pack in sturdy container
- Seal all seams
- Identify package with labels both outside and inside – be sure to include address, phone and email address (if available)
- Include completed submission form and photos – be sure they are kept dry
- Submit digital images electronically



Photos: Gail Ruhl, Purdue University



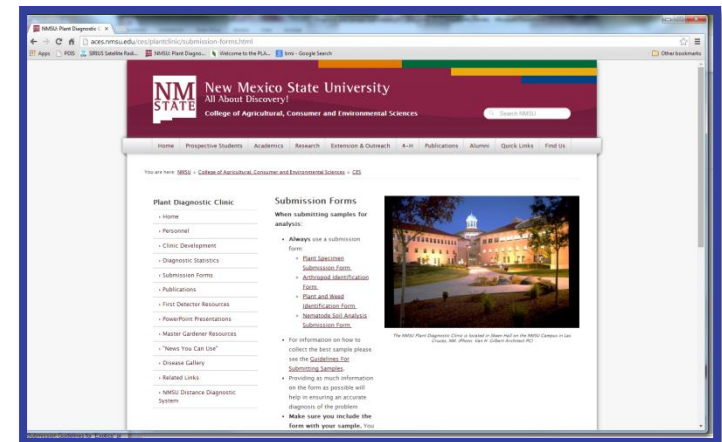
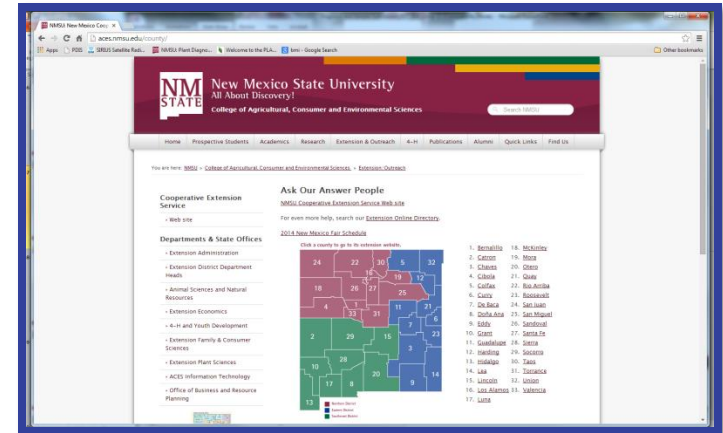
# Submission Forms

- Plant Specimens, Arthropods, and Plant/Weed Identification Forms

- County Extension Agent
- NMSU Plant Diagnostic Clinic Webpage:

<http://aces.nmsu.edu/ces/plantclinic/submission-forms.html>

- Jason in the Plant Diagnostic Clinic (575-646-1965 or [jfrench@nmsu.edu](mailto:jfrench@nmsu.edu))



# Plant Specimen Submission Form

- Critical to an accurate diagnosis
- Be complete and thorough
- Reminds you of the information needed
  - Host Identification
  - Specific description of the problem/symptoms
  - When problem began
  - Whether or not the problem is getting worse
  - Gradual or sudden symptom development
  - Distribution, incidence and severity
  - Growing conditions
  - Cultural information
  - Weather conditions
  - History of previous problems

VARIETY (genus and species, and/or common name of plant) \_\_\_\_\_

AGE OF THE PLANT: \_\_\_\_\_ PLANTING DATE: \_\_\_\_\_

SYMPTOMS (mark all that apply):

Plant parts affected:  roots/crowns  stems/branches  leaves  fruit  whole plant

Symptoms:  spots  tipburn  distortion  mosaic/mottle  chlorosis  necrosis  rot

mildew  blisters  defoliation  wilt  dieback  blight  stunting  canker  galls

Description (be as specific as possible, describe the whole plant - remember the clinician is only seeing the specimen submitted): \_\_\_\_\_

When did symptoms first appear: \_\_\_\_\_

Are the symptoms (mark one):  spreading or  localized

Symptom development (mark one):  gradual or  sudden

Distribution of diseased plants (mark one):  scattered  clustered  in a row or pattern

Number or percent of plant(s) infected \_\_\_\_\_

SOIL TYPE (mark all that apply):

Sand  silt  clay  Well drained  Poorly drained  Heavy  Light

GROWING CONDITIONS (mark all that apply):  Indoors  Greenhouse  Home Garden  Lawn

Landscape  Organic Garden  Commercial Field  Other \_\_\_\_\_

WEATHER CONDITIONS (immediately prior to and during development of symptoms) (mark all that apply):

Wet  Dry  Humid  Windy  Dusty  Hail

Temperature (°F) \_\_\_\_\_ Other Conditions \_\_\_\_\_

IRRIGATION HISTORY: (Mark all that apply):

Furrow  Flood  Drip  Sprinkler  Hand

How often? \_\_\_\_\_ How much water is applied? \_\_\_\_\_

FERTILIZATION HISTORY: (type, nutrient ratio, amount applied, and frequency of application) \_\_\_\_\_

CHEMICALS APPLIED (chemical name, method and frequency of application and amount applied) \_\_\_\_\_

CROPPING HISTORY (for agricultural fields or home gardens):

Rotation (previous 3 years) \_\_\_\_\_

Past Problems (in field) \_\_\_\_\_

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Revised April 2013 Las Cruces, NM

# Mailing Plant Specimens

- Keep samples cool prior to shipment
- Mail specimens as soon as possible after collection
- Avoid mailing over weekends and holidays
- For best results, use overnight delivery






# Submission Guidelines for “Exotics” or “High Risk Pests”

- Don't be a source spreader!
- Double bag
- Disinfect outside of sample bags or containers
- Disinfect hands, counter tops, and other items that may have come in contact with sample
- Promptly notify County Extension Agent or the Plant Diagnostic Clinic
- Hand deliver or mail by overnight delivery
- Avoid alarmist behavior - Consider security and only notify necessary personnel



Photo: Stephanie Stocks, University of Florida

# Useful Sample Submission Videos

- Videos available from the NPDN YouTube channel – <http://www.youtube.com/user/npdnchannel>
- Submitting a plant sample 
- Submitting an insect sample in preservative 
- Submitting a soft bodied insect sample 
- Submitting a sample of an insect attached to a plant 

Remember:

Diagnosis is a team effort and the diagnosis received is only as good as the sample submitted and the information provided



Photo: <http://www.clipartbest.com/>