Step-by-Step Guide to Field Diagnostics

Richard Heerema, Ph.D.
Extension Pistachio and Pecan Specialist
New Mexico State University
Causal Agents of Disorders

• **Biotic**
  – Fungi
  – Bacteria
  – Viruses
  – Phytoplasma
  – Nematodes
  – Insects & Mites

• **Abiotic**
  – Soil moisture extremes
  – Temperature extremes
  – Salts
  – Air pollution
  – Wind, light effects
  – Mechanical damage
  – Pesticide damage
Diagnosing Disorders

• The **process** of determining the cause of an abnormality

• Diagnosis is a **team** effort
  – Grower/Consultant/Manager
  – Farm Advisor/Extension Agent
  – Diagnostic Clinic

• Conclusions are derived from **critical evaluation of the trees and the environment**
  – Requires a blend of good observational skills, science, and experience
Diagnostic Advice

• Don’t jump to conclusions
  – Keep an open mind

• Be a detective: observe, question, gather clues

• Evaluate the whole plant, the whole orchard, and the areas around the problem area

• When possible…
  – Dig up and look at roots
  – Cut open stems, branches, fruits, etc.
The First Step: Spot the Problem

• Diagnosis begins with the observation that there is a problem with the tree(s)
  – Know the healthy/normal appearance (cultivar diffs)
  – Symptoms

• This means you need to physically be in your orchard on a regular basis.
Symptoms

Symptoms usually develop because the causal agent:

- Produces (or induces the plant to produce) enzymes, toxins, or growth regulator imbalances

- Interferes with specific cellular functions
  - The particular symptom develops based on whatever plant process(es) are affected
The Difficulties with Symptoms

- Change over time (progression)
- Vary with severity/virulence of the stressor/pathogen
- Vary due to age or stage of the tree
- Vary due to environmental conditions during and after infection

Symptoms are often insufficient for diagnosis
Symptoms are Complex!

• Symptoms are not always specific to causal agents

• Causal agents often affect more than one plant process at a time leading to complex symptomology

• Plants may be affected by more than one causal agent (abiotic and biotic) at a time
  – adds to complex symptomology

Symptoms are often insufficient for diagnosis
Abiotic disorders may predispose the tree to biotic disorders!

• **Biotic**
  - Fungi
  - Bacteria
  - Viruses
  - Phytoplasma
  - Nematodes
  - Insects & Mites

• **Abiotic**
  - Soil moisture extremes
  - Temperature extremes
  - Salts
  - Air pollution
  - Wind, light effects
  - Mechanical damage
  - Pesticide damage

MAY PREDISPOSE TO BIOTIC!
The Second Step:
Gather *accurate* and *complete* information

- Situation of the Orchard
- History of the Disorder
- Spatial Variability
- Symptom Expression
Critical Information Needs

• Situation of the Orchard
  – Cultivar and rootstock (incl. whether clonal or seedling)
  – Age and production history
  – Soil textures
  – Cultural practices:
    • irrigation, fertilizers, pesticides…
  – Weather conditions before and during symptom development
  – Historic land use of orchard site.
  – Land use in adjacent properties
  – Soil and water analyses
  – Leaf tissue nutrient analyses
Critical Information Needs

• History of the Disorder in the Orchard:
  – When the problem began. Or when symptoms were first noticed.
  – Whether it is a chronic problem
  – Whether the symptoms are spreading (within tree or to other plants in the orchard)
Critical Information Needs

- Spatial Variability of the Disorder in the Orchard:
  - Percentage of orchard affected
  - Pattern of symptoms in orchard
    - Scattered
    - Clumped
    - Random
  - Other plants in orchard affected
Critical Information Needs

Symptom expression

The plant parts affected
Top-down or bottom-up in canopy
Where is PRIMARY site of injury?

The progression in severity on plant over time
Evaluating Leaf Symptoms

• Uniformity or patterns?
  – Leaf and plant
  – Size of spots

• Margin (borders)?
  – Thickness
  – Color

• Spread or growth?
  – Edge definition
  – Merging of spots

• Fruiting bodies?
The Third Step: Collect Specimens

• Important for accurate diagnosis
• All specimens should be fresh, kept refrigerated
• Submit samples showing all stages of problem
• In some cases it may be best to collect the whole tree if possible
Sampling:
Include samples from all affected organs

- Do not destroy signs or symptoms

- Roots: Remove soil, include tissue above and below visible lesions

- Stem and leaf: Include tissue above and below visible lesions

- Flower, fruit, seed: Collect the entire organ
Sampling Techniques: Handling and Packing

• Identify/label correctly every specimen
• Package delicate material in a sturdy box
• Do not add water or wet paper towels
• Ship immediately overnight and early in the week
PLANT SPECIMEN SUBMISSION FORM

Sample No. ________________________________ Date Sample Received: ______________

PLEASE REMEMBER: Successful plant disease diagnosis is a team effort. Proper diagnosis begins with the submission of a good-quality specimen accompanied by accurate and complete information. Please follow these guidelines and submit the best sample possible (if the sample is insufficient for diagnosis, you will be asked to submit a new sample).

If you have any questions, please call before submitting your sample [575-646-1621 or 575-646-1800].

COLLECTION:
1. DO NOT send dry or dead material.
2. Collect several samples showing various stages of symptom expression. When the whole plant cannot be collected, collect sample from the margin of the diseased area. Include a healthy plant of possible.
3. Send a representative sample from all parts of the plant. Dig plants out of the soil (DO NOT PLUCK). DO NOT wash roots. Gently shake excess soil from roots.
4. For turfgrass, select a 2-4” sample (including at least 2” of soil) from the margin of the diseased area.
5. Wrap sample in dry paper towel or newspaper and place in a paper or plastic bag. Do not use plastic if there is a lot of moisture associated with the sample. Never put moisture in sample.
6. Submit a completed Plant Specimen Submission Form. Processing of the sample may delay the specimen received without the proper form or if information provided is insufficient.

PACKING:
1. Keep sample cool prior to shipment.
2. Pack the sample carefully in a sturdy box or padded envelope. Be sure not to crush specimens.
3. Mail immediately [prepaid postage is recommended]. Avoid mailing over weekends and holidays.

ADDRESS PACKAGE TO:
New Mexico State University
Attn: Plant Diagnostic Clinic
Box 30003, MSC 304
Las Cruces, NM 88003

For Overnight UPS or FedEx:
New Mexico State University
Attn: Plant Diagnostic Clinic
Shift College Avenue
Sante Fe Hall Room 1410
Las Cruces, NM 88003

PLEASE FILL OUT THE FOLLOWING:
Grower/Owner (Name, Address, Phone No.) Submitted by: (if different from grower)

E-Mail Address:

Level of Diagnostic Services Requested (if no box is checked, diagnosis will be completed as needed):

- Basic evaluation ($25.00 non-commercial, $40.00 commercial, $50.00 commercial turfgrass)
- Extension or University submitted – no fee.
- 5% surcharge for out-of-state samples

Special request or instructions:

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/crown, stems/branches, leaves, fruit, whole plant
- Symptoms: spot, tipburn, distortion, mosaic/mottle, chlorosis, necrosis, rot

When did symptoms first appear: __________________

Are the symptoms: spreading or localized

Symptom development (mark one): gradual or sudden

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

Number or percent of plant(s) infected __________________

SOIL TYPE (mark all that apply):
- Sandy
- Silty
- Clay
- Very sandy
- Loamy sandy
- Loamy
- Organic

GROWING CONDITIONS (mark at that apply):
- Indoor
- Greenhouse
- Home Garden
- Lawn
- Landscape
- Organic Garden
- Commercial Field

WEATHER CONDITIONS (immediately prior to and during development of symptom) (mark all that apply):
- Wet
- Dry
- Humid
- Windy
- Dusty
- Rain

Temperature (°F)

IRRIGATION HISTORY: (mark all that apply):
- Fertigation
- 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 ornamental gardens):
- Rotation (previous 3 years)
- Past Problems (in brief)

New Mexico State University is an equal-opportunity affirmative action employer and educator. NMSU and the U.S. Department of Agriculture cooperating.

Revised April 2013
Ian DeCesar, NM
Some General References

- **Plant Pathology**
  - George N. Agrios
  - Fifth Edition

- **Diseases of Temperate Zone Tree Fruit and Nut Crops**
  - Kamprath, E. J.; Downie, J. R.
  - Second Edition

- **Almonds**
  - Integrated Pest Management for Almonds
  - Volume 1

- **Westcott’s Plant Disease Handbook**
  - R. Kenneth Horst
  - Eighth Edition

- **Walnuts**
  - Integrated Pest Management for Walnuts
  - Volume 2

- **Stone Fruits**
  - Integrated Pest Management for Stone Fruits
  - Volume 4

Many great resources available at [http://anrcatalog.ucdavis.edu](http://anrcatalog.ucdavis.edu)
Online Resources

http://fruitsandnuts.ucdavis.edu
### Online Resources

This document contains information about the Plant Pest Diagnostics Center (PPDC) at the California Department of Food and Agriculture. The PPDC is a scientific resource that provides timely and accurate plant pest diagnostics and professional expertise to clients. The center’s activities include:

- **Diagnostic Activities**
- **Research Activities**
- **Seminar Series**
- **Job Opportunities**

#### Quick Links

- Pest Identification and Treatment Sheets
- California State Collection of Arthropods
- CPDA Herbarium
- CPDA Seed Herbarium
- CPDA Nematode Collection
- CPDA Plant Pathogen Collections
- National Plant Diagnostics Network (NPDN)
- Western Plant Diagnostics Network (NPWDN)

#### Plant Pest Diagnostics Center Overview

The PPDC serves as a scientific resource, providing timely and accurate plant pest diagnostics and professional expertise to clients. The center’s tasks include:

- Timely and accurate diagnosis of plant pests, weeds, and diseases, and evaluation of seed quality and viability.
- Expert consultation for pest prevention programs and for external clientele.
- Services for the improvement of plant quality and for export of agricultural products.
- Cutting-edge research on the identification and characterization of new plant and disease species, and on the methodologies to improve diagnostic procedures.
- Maintenance and curation of critical scientific resources, including the California State Collection of Arthropods, the Herbarium, the Seed Herbarium, and plant disease collections.
Thank You!

Acknowledgements
Louise Ferguson, University of California, Davis
University of California Integrated Pest Management Program
Natalie Goldberg, New Mexico State University