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Diagnostic Tips for the Problem Lawn

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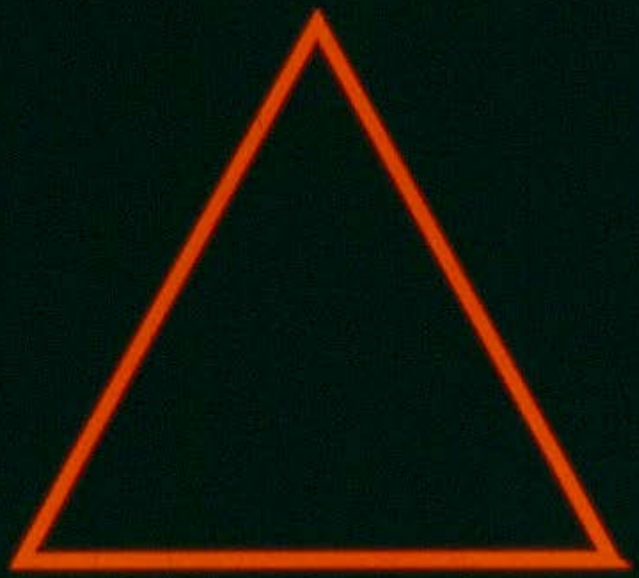
Plant Pathology 101

1. What is a Disease?
2. Disease Triangle Concept
   a) Host Plant Condition
   b) Causal Agents
   c) Environmental Impact
3. Recognizing Diseases
   a) Symptoms
   b) Signs

Plant Pathology 101

- **Plant Disease:**
  - any disturbance of a plant that interferes with its normal structure, function, or economic value, or
  - any condition of a plant that is contrary to grower expectations

THE DISEASE TRIANGLE



Host Plant Condition

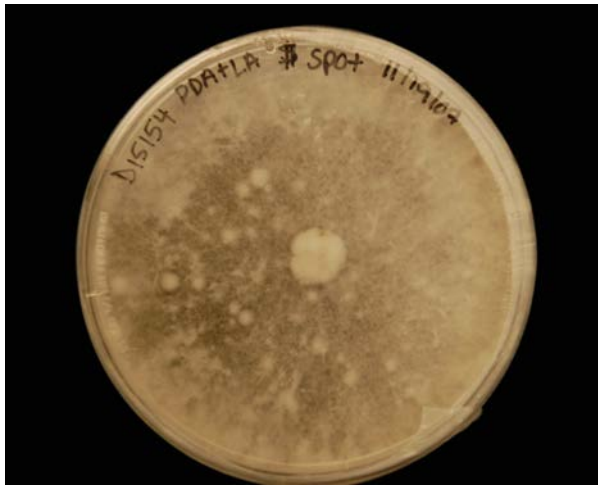
- Most plants resist or tolerate attack
- Plant must be susceptible to attack
- Resistance and susceptibility different degrees of the same thing
  - ✓ influenced by genetics
  - ✓ influenced by environment
- Immunity is absolute

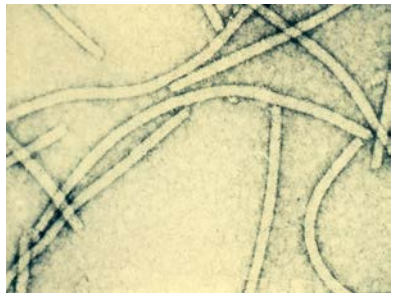
Two types of causal agents:

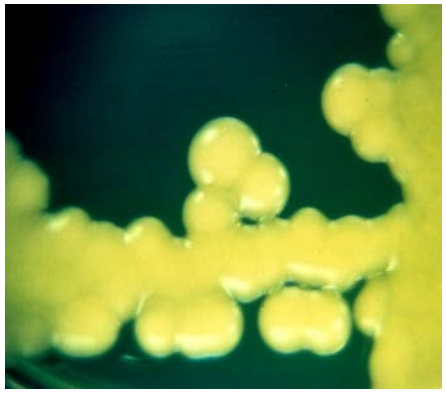
1. **Biotic** (infectious)
   - organism (pathogen) grows, multiplies, and spreads to other plants
   - **10% of plant problems reported**
2. **Abiotic** (non-infectious)
   - environmental conditions that impact plant development (physiogens)
   - much more common: **90% of plant problems reported (injury not disease)**

Biotic Causal Agents - Pathogens

- Fungi
- Bacteria
- Virus
- Viroid
- Mollicute
- Protozoa
- Algae
- Insect
- Mite
- Parasitic plant
- Nematode







Causal Agent

- Pathogen must be present
- Pathogen must be pathogenic
- Pathogen must be virulent
  - ✓influenced by genetics
  - ✓influenced by environment

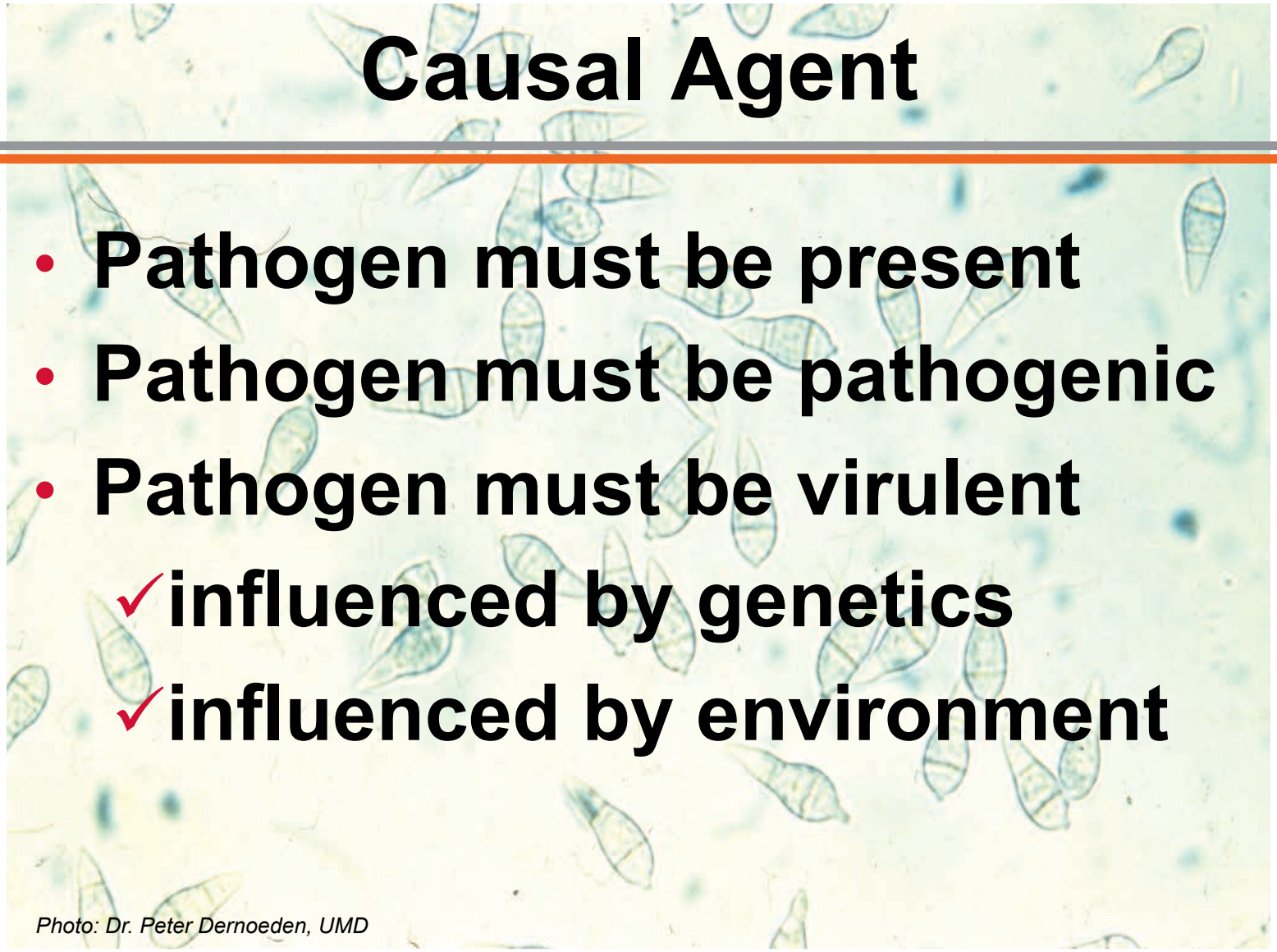


Photo: Dr. Peter Dernoeden, UMD

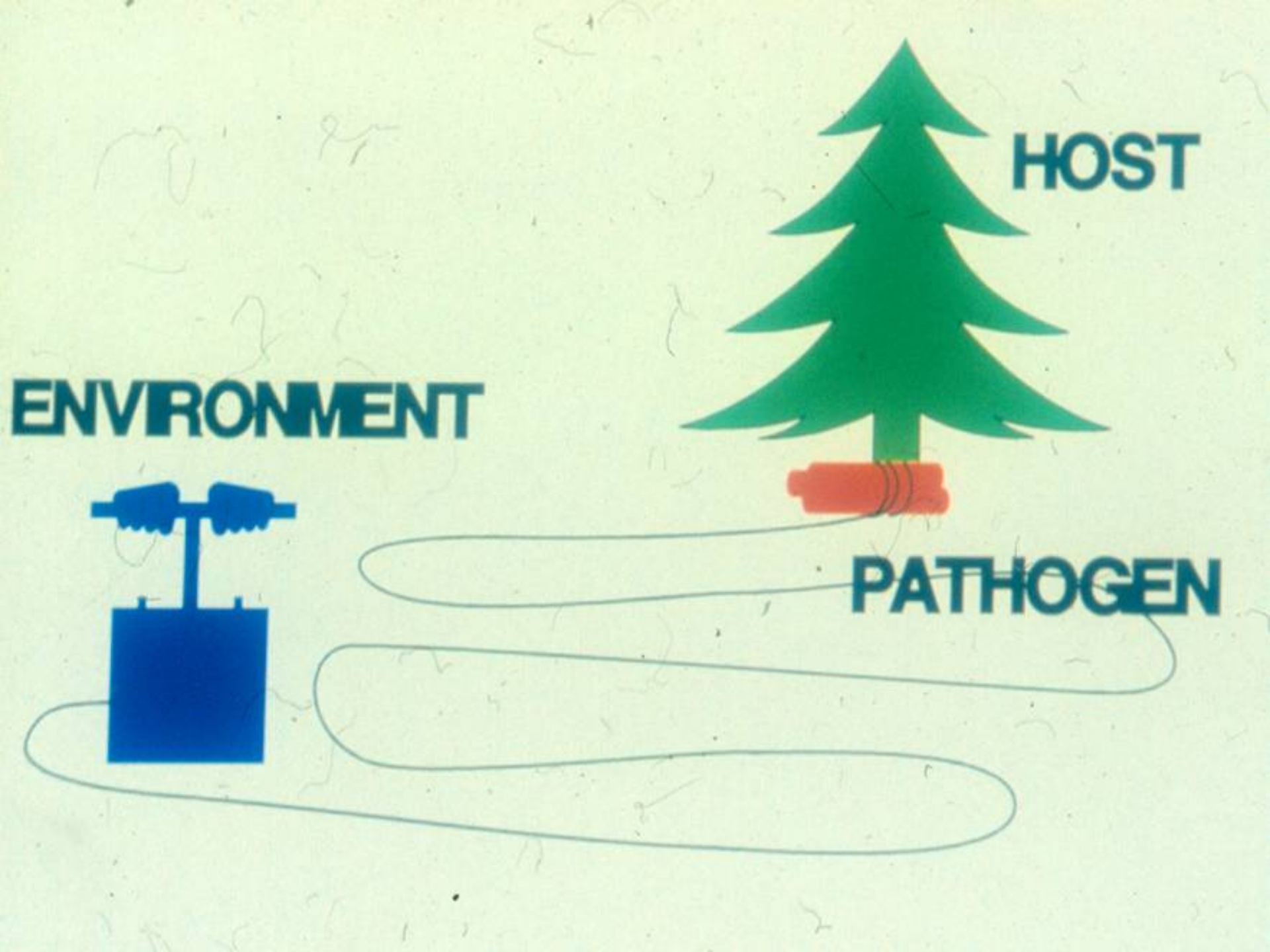
Abiotic Causal Agents - Physiogens

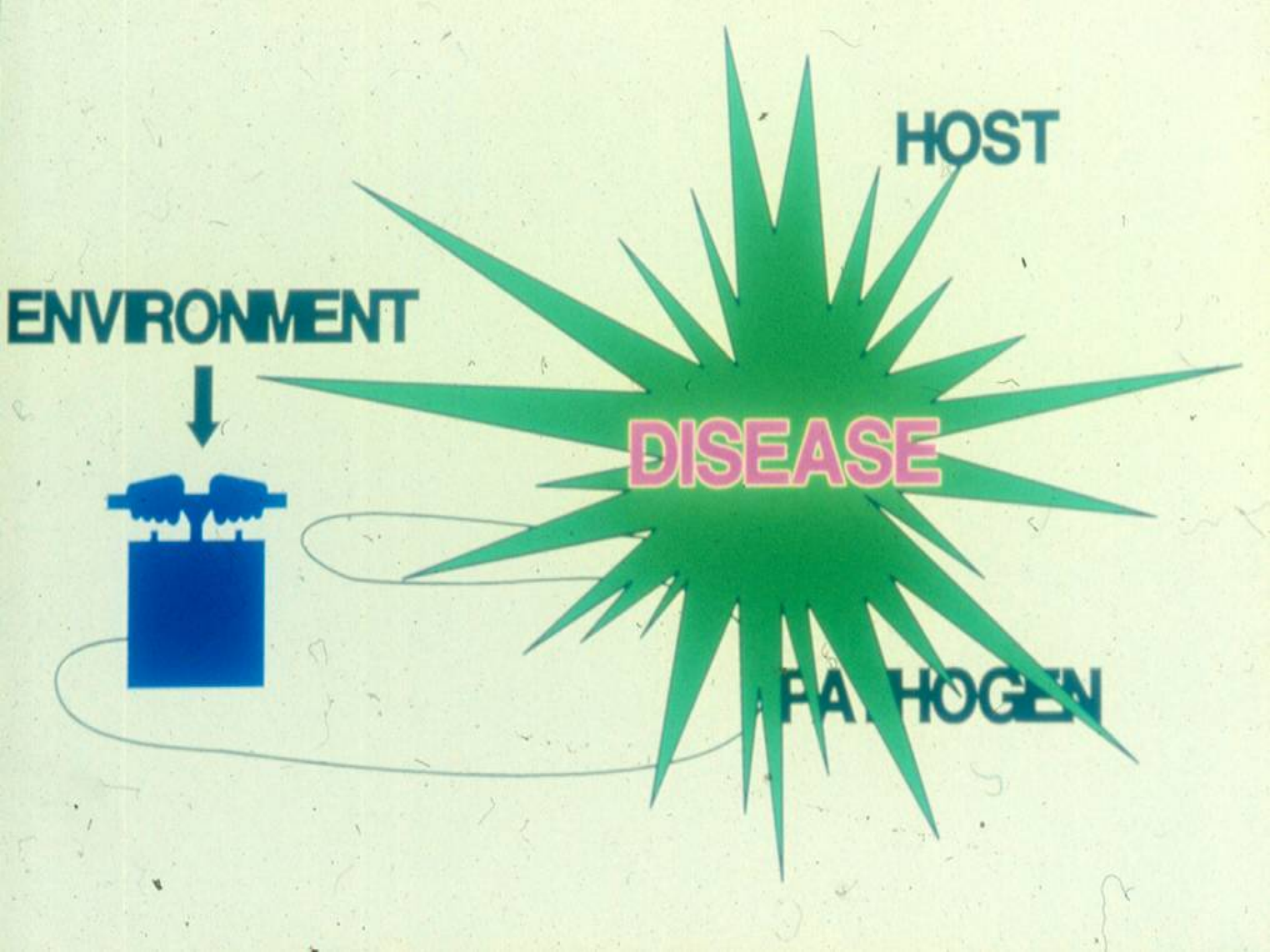
- Physical factors
  - ✓ Temperature
  - ✓ Moisture
- Chemical factors
  - ✓ Air pollutants
  - ✓ Pesticides
  - ✓ Fertilizers and salts
- Mechanical factors
  - ✓ Everything else

Photo: Ann Gould, NJAES

Environmental Condition

- Provides pathogen opportunities
  - ✓ influences host plant condition
  - ✓ increases pathogen virulence
- Predisposing conditions
  - ✓ site
  - ✓ weather
  - ✓ management


HOST
ENVIRONMENT
PATHOGEN


HOST
ENVIRONMENT
DISEASE
PATHOGEN

Turfgrass Cultural Practices that Influence Disease Severity

- seed selection
- mowing
- fertilization
- irrigation
- aerification

Recognizing Diseases

- **Symptoms -**
  - ✓ observable condition of abnormal physiology in the plant
- **Signs -**
  - ✓ physical presence of the causal agent or clear evidence of abiotic stress factors

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Symptom descriptions

leaf spot, blight, tip blight, dieback, flagging, chlorosis, necrosis, canker, wilt, root rot, witches broom, mottling, interveinal necrosis, epinasty, scorch, crown rot, defoliation, boring phyllody, leaf blotch, rust, damping off, soft rot, mummification, stem pitting, gall, shot-hole, bleeding, slime flux, blast, scald, bronzing, staghead, tumefacation, fasciation, hairy root, knots, enation, shoestring, erinos, stipple, notching, chewing, skeletonization, rugose, puckering, edema, intumescence, russet, scab, callus, leafroll, leaf curl, croziers, dwarfing, stunting, rosetting, atrophy, etiolation, spiralism, hyperelongated, bunchy, cresting, dead


Photo: Crop Science Society


Photo: APS Press

Photo: Bruce Clarke, NJAES

Symptoms

- **Caution**
  - ✓ Not the be all – end all
  - ✓ Simple starting point
  - ✓ Don’t jump to conclusions
  - ✓ Need more information

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Signs

Fruiting body, sporocarp, cliestothecia, pycnidia, mushroom, hyphae, stroma, spores, conidia, sclerotia, conidiophore, perithecia, apothecia, synnema, cyst, egg, cast skin, nematode, insect, plasmodium, sporodochia, acervulus, aecium, oospore, zoospore, cirrhus, basidiocarp, ascus, sporangium, teliospore, uredium


Photo: APS Press


Photo: APS Press

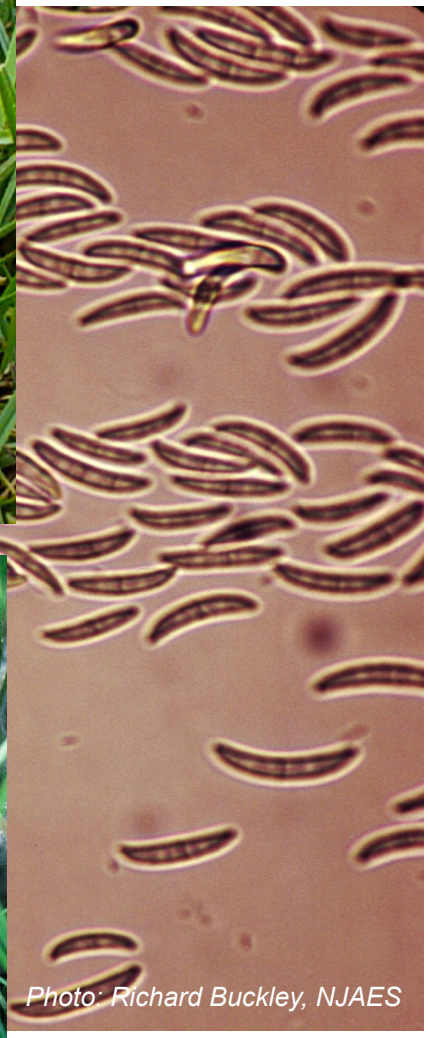
Photo: Richard Buckley, NJAES

Signs

- **Caution**
  - ✓ Not the be all – end all
  - ✓ Simple starting point
  - ✓ Don’t jump to conclusions
  - ✓ Need more information

Basic Diagnostics 101

1. Identify the plant
2. Observe the symptoms
3. Evaluate the predisposing conditions
4. Identify the sign
5. Synthesize the information

Step 1: Identify the plant

- **Understand the needs of the plant**
  - ✓ What are agronomic requirements?
- **Provides a list of pathogens**
  - ✓ Key plant / key pest concept

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Identify the Plant

Zoysia turns brown in winter in stark contrast to the perennial ryegrass

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Identify the Plant

Perennial ryegrass suffers in the heat of the summer

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Brown Patch

No disease on creepers – epidemic on colonials

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Rust

Selective thinning from rust infection on Kentucky bluegrass cultivars

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Gray Leaf Spot

Genetic variation of gray leaf spot resistance in perennial ryegrass in a turf trial seeded August 17, 2001 at Adelphia, NJ.

Photo: Dr. William Meyer, NJAES

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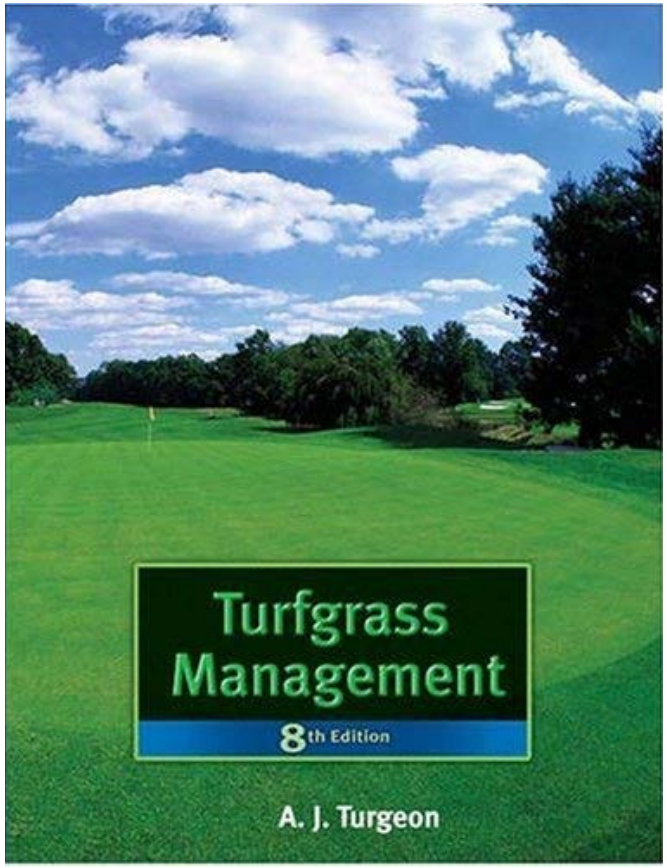
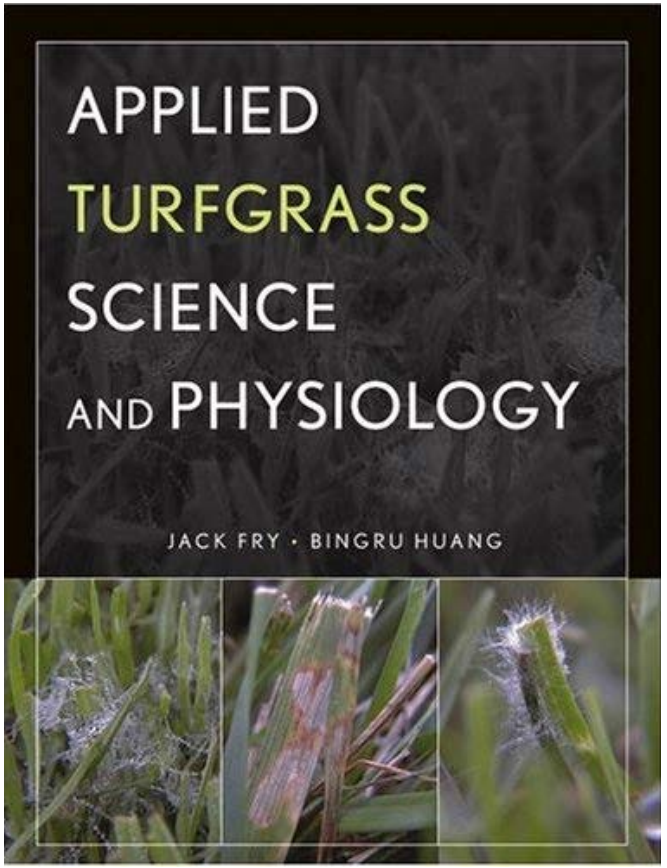
Chinch Bug

Know your plant materials!





- ✓ **Proper identification is key**
- ✓ **What are the agronomic requirements for your turf?**

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Temperature and Moisture Stress

Turfgrass	Relative Heat Resistance
Tall fescue	Very Good
Kentucky bluegrass	Good
Perennial ryegrass	Fair
Fine fescues	
Creeping bentgrass	
Annual bluegrass	Poor
Rough bluegrass	

From Applied Turfgrass Science and Physiology, J. Fry and B. Huang

Step 2: Define the problem

- **Evaluate the entire plant**
  - Identify the dysfunctional plant part or system
- **Evaluate the plant community**
  - Each plant family has similar problems
- **Look for patterns**
  - Relate to environmental, site, and cultural inputs
- **Look for symptom progression**
  - Disease implies a life cycle
  - Sudden death or decline related to abiotic stress

The Diagnostic Process

Step 2: Observe symptoms

- **Evaluate the entire plant**
  - **Identify the dysfunctional plant part or system**
- **Evaluate the plant community**
  - Each plant family has similar problems
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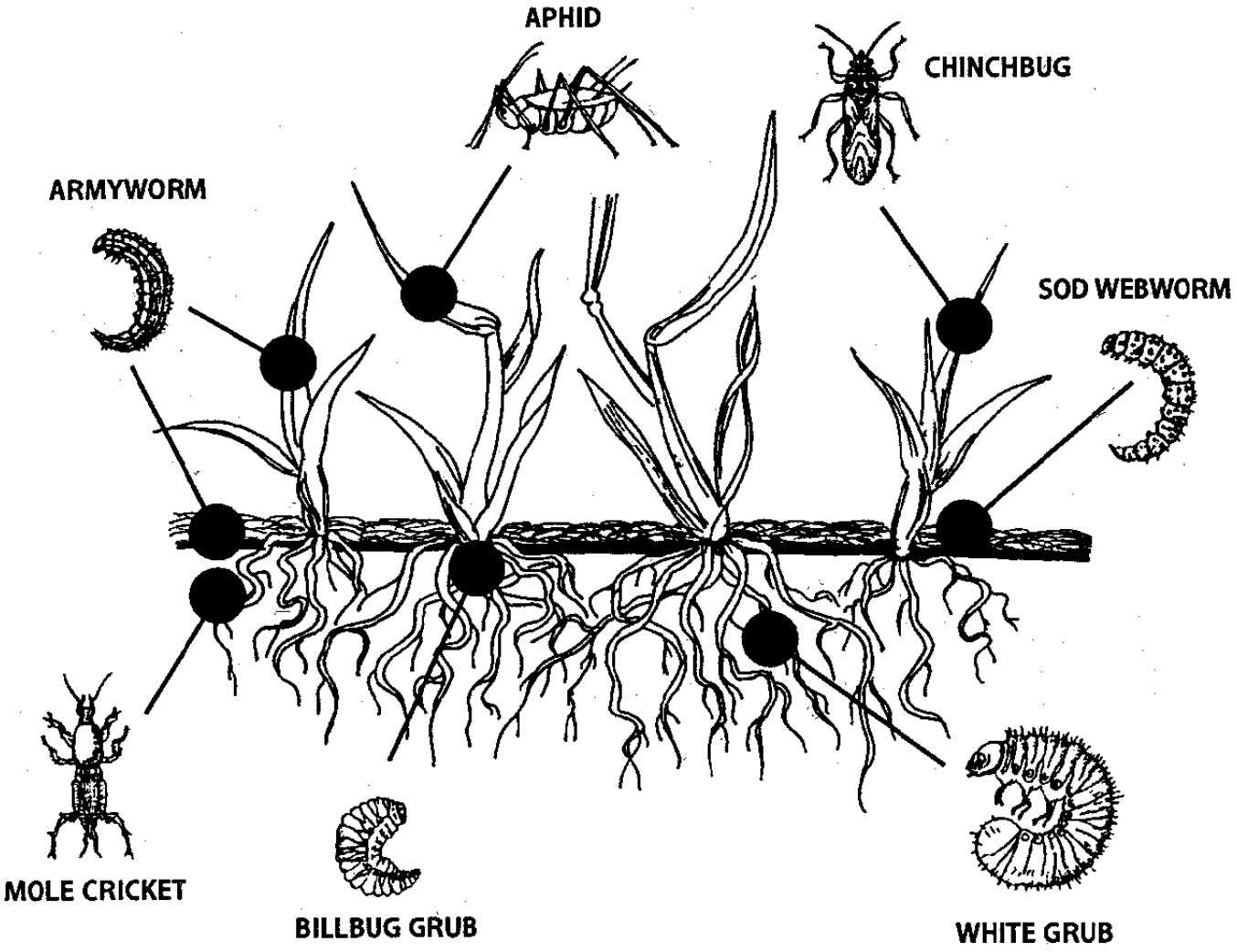
Evaluate the Entire Plant

Target principle – turf zones



Turf zones:

Foliar/stem

Stem/thatch

Thatch/soil

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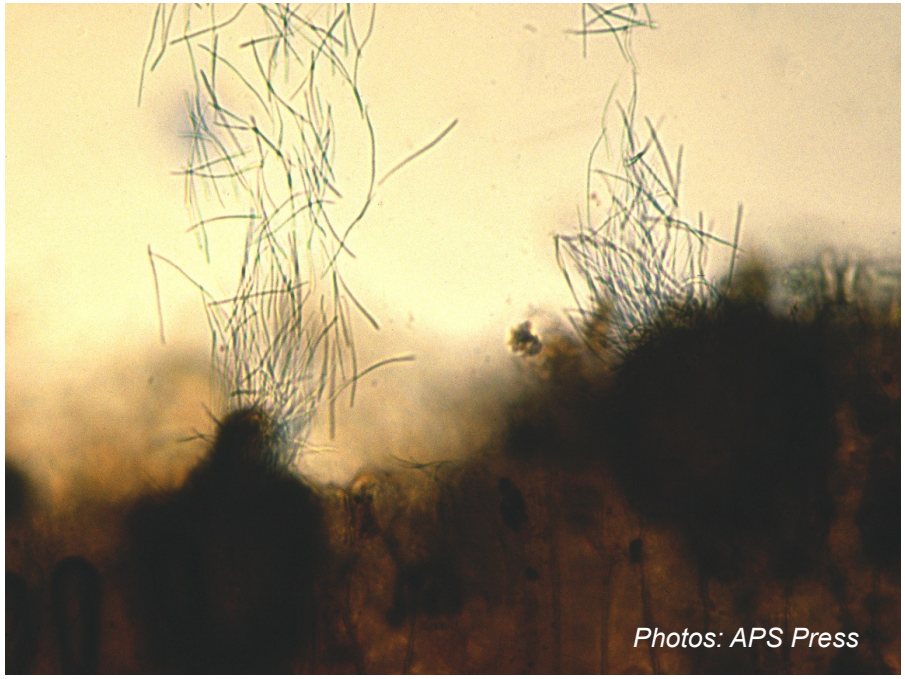
Septoria Leaf Blight

leaf tip blight symptom with pycnidia

Septoria macropoda **pycnidia with emerging conidia**



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Leaf Spot and Melting Out

Photo: Sabrina Tirpak, NJAES

reddish brown rot of crown

Photo: APS Press

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Summer Patch

Photo: John Inguagiato, UCONN

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Magnaporthe poae

Darkly pigmented ectotrophic runner hyphae

Step 2: Observe symptoms

- Evaluate the entire plant
  - Identify the dysfunctional plant part or system
- Evaluate the plant community
  - Each plant family has similar problems
- Look for patterns
  - Relate to environmental, site, and cultural inputs
- Look for symptom progression
  - Disease implies a life cycle
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Consider the Plant Community

Similar symptoms on unrelated plants are likely due to a non-living (abiotic) cause

Similar symptoms on related plants are likely due to a living (biotic) cause

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Acute Heat Stress

Large turf areas rapidly decline after a week above 100°F

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Consider the Plant Community

All plants rapidly decline after a week above 100°F

Step 2: Observe symptoms

- **Evaluate the entire plant**
  - Identify the dysfunctional plant part or system
- **Evaluate the plant community**
  - Each plant family has similar problems
- **Look for patterns**
  - **Relate to environmental, site, and cultural inputs**
- **Look for symptom progression**
  - Disease implies a life cycle
  - Sudden death or decline related to abiotic stress

Recognize Patterns

- Uniform - abiotic
- Random - biotic

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Drop Spreader Disease

Photo: Richard Buckley, NJAES

What can you say about this?

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Pink Snow Mold

Random patches coalesce to kill larger irregular areas

Step 2: Observe symptoms

- **Evaluate the entire plant**
  - Identify the dysfunctional plant part or system
- **Evaluate the plant community**
  - Each plant family has similar problems
- **Look for patterns**
  - Relate to environmental, site, and cultural inputs
- **Look for symptom progression**
  - **Disease implies a life cycle**
  - **Sudden death or decline related to abiotic stress**

Observe symptom progression

- Progressive - biotic
- Non-progressive - abiotic

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Gray Leaf Spot

Early leaf spot and thinning of perennial ryegrass

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Gray Leaf Spot

Early symptoms appear like pythium blight or dollar spot

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Gray Leaf Spot

Spots rapidly enlarge to blight larger turf areas

Photo: Dr. Peter Dernoeden, UMD

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Gray Leaf Spot

Severe disease causes complete failure of turf area

Photo: Dr. Peter Dernoeden, UMD

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Glyphosate vandalism

Step 2: Observe symptoms

- **Define the problem**
  - ✓ **Abiotic verses biotic cause?**
  - ✓ **Recognize classic symptom expression**

Observe Classic Symptoms

- **Population**
  - ✓ spot, patch, ring, thinning, irregular area
- **Individual plants**
  - ✓ tip blight, leaf lesion, crown rot, root rot

Turf disease by symptom expression

- **Spots**
  - ✓ Dollar spot
  - ✓ Red thread/pink patch
  - ✓ Bentgrass dead spot
  - ✓ Copper spot
- **Patches**
  - ✓ Brown patch
  - ✓ Summer patch
  - ✓ Take all patch
  - ✓ Red thread/pink patch
  - ✓ Snow molds
- **Rings**
  - ✓ Yellow patch
  - ✓ Fairy ring
  - ✓ Summer patch
  - ✓ Take all patch
- **Thinning/irregular areas**
  - ✓ Gray leaf spot
  - ✓ Pythium blight
  - ✓ Rusts and smuts
  - ✓ Anthracnose
  - ✓ Powdery mildew

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Dollar Spot

1 inch spots of dead creeping bentgrass

Photo: Richard Buckley, NJAES

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Brown Patch

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Summer Patch

Photos: Richard Buckley, NJAES

Classic “frog eye” in Kentucky bluegrass

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Rust

thinning and yellowing from rust infection on Kentucky bluegrass

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Pythium Blight

Blighted tall fescue

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Sod Webworm

early webworm damage

dollar spot-like spots of chewed grass

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Masked Chafer Damage

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Oriental Beetle Damage

Turf disease by symptom expression

- **Leaf lesion**
  - ✓ Dollar spot
  - ✓ Leaf spot and melting out
  - ✓ Brown patch
  - ✓ Gray leaf spot
- **Leaf blight**
  - ✓ Ascochyta leaf blight
  - ✓ Septoria leaf blight
  - ✓ Rusts and smuts
  - ✓ Anthracnose
  - ✓ Gray snow mold
- **Crown rot**
  - ✓ Leaf spot and melting out
  - ✓ Anthracnose
- **Root rot**
  - ✓ Summer patch
  - ✓ Take all
  - ✓ Necrotic ring spot

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Leaf Spot and Melting Out

small oval lesions 1/8th inch

"football"

purple border/ tan center

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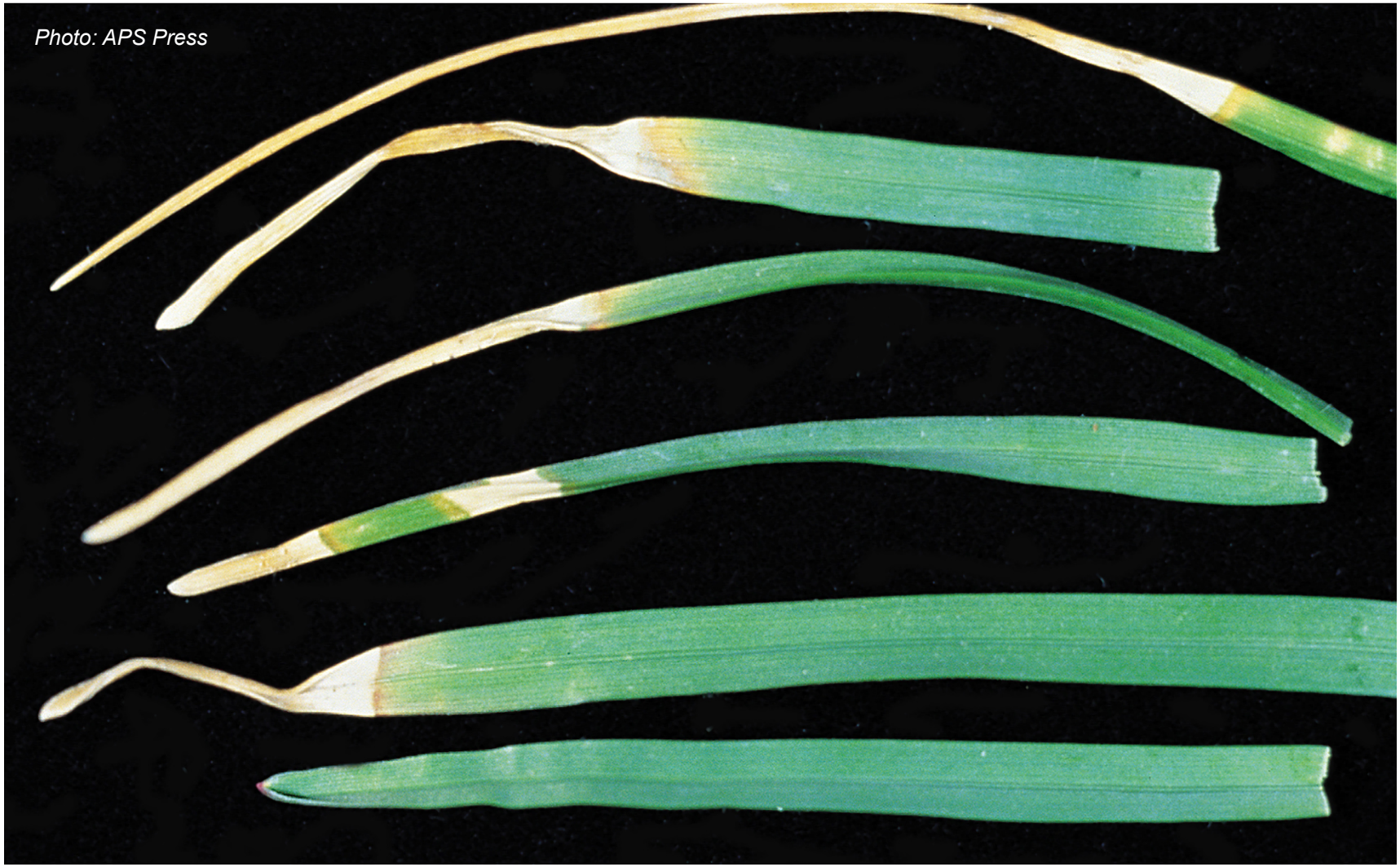
Ascochyta Leaf Blight



leaf tip blight symptom

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Anthracnose

basal fungal stroma on crown of *Poa annua*

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Necrotic Ring Spot

Impact of *Ophiosphaerella korrae* infection on bluegrass roots

Photos: APS Press

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Annual Bluegrass Weevil

Leaf notching by adult weevils

The Diagnostic Process

Step 3: Evaluate the predisposing conditions

- **Record the weather condition**
  - Temperature and moisture stress are key
- **Analyze the site condition**
  - Look for causes or contributing factors; soil chemical status; drainage, exposure, etc.
  - Infrastructure problems clearly evident
- **Evaluate the management program**
  - What materials were used and how much?
  - Examine the application equipment
  - Observe other cultural practice

Step 3: Evaluate the predisposing conditions

- **Analyze the site**
  - ✓ Drainage
  - ✓ Shade and exposure
  - ✓ Air movement
  - ✓ Contour
  - ✓ Soil chemical properties
  - ✓ Soil physical properties
  - ✓ Other infrastructure

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Wet Feet

Damage from standing water

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Shade

Thin turf in shade: this is a good as it gets.

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Indirect Heat Stress

Photo: Jason Osterhoudt, Echo Lake CC

Site conditions (heat sink) impact dormancy

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Mechanical Injury

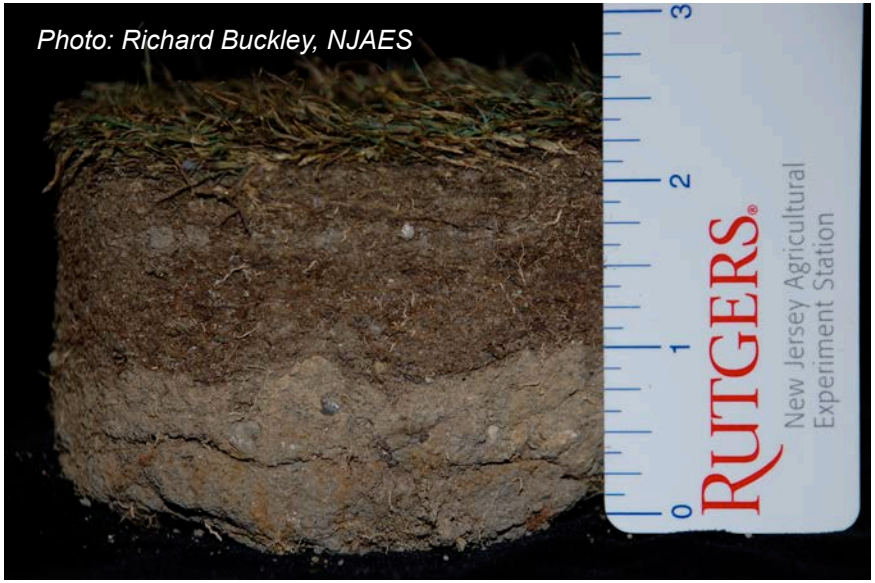
Photo: Richard Buckley, NJAES

Traffic damage to tall fescue

Root Zone Problems

- ✓drainage
- ✓layering
- ✓anaerobiosis
- ✓black layer
- ✓thatch


Photo: Sabrina Tirpak, NJAES



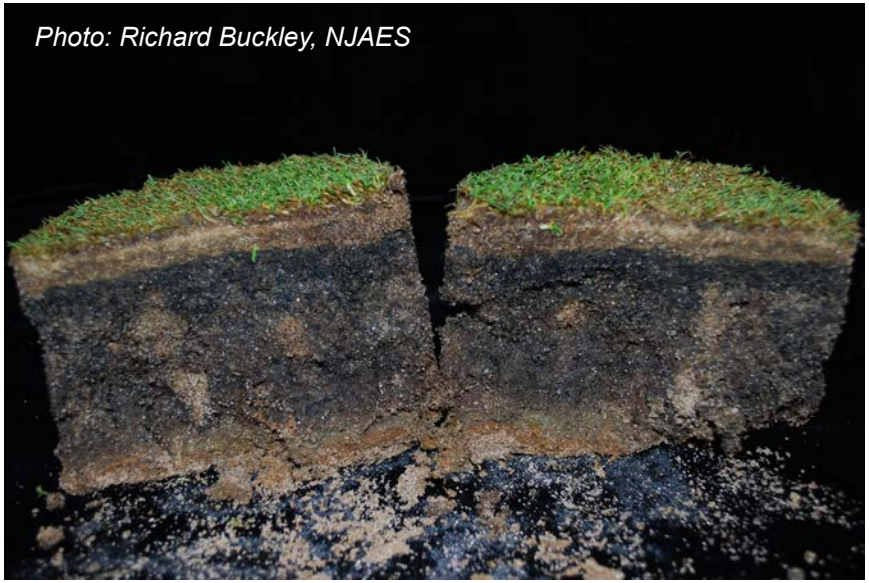


Photo: Richard Buckley, NJAES

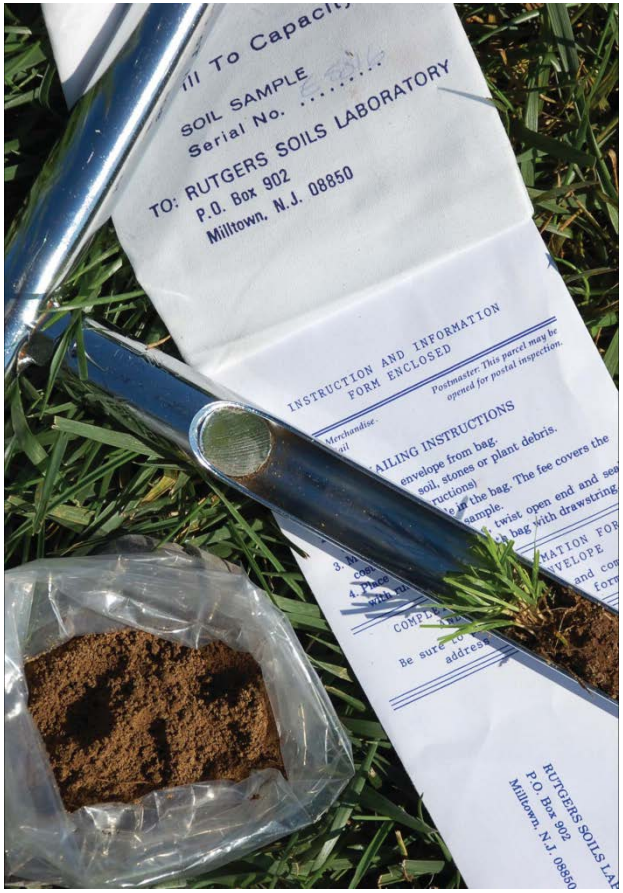
Weed indicators of site conditions

High pH = plantain

Low pH = sorrel

Nutritional Testing

- Systematic sampling of healthy turf areas
- Estimates level of available nutrients



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Moisture Stress

Precision irrigation coverage

Step 3: Evaluate the predisposing conditions

- **Record the weather condition**
  - ✓ Temperature
  - ✓ Relative humidity
  - ✓ Rainfall
  - ✓ Evapotranspiration rates
  - ✓ Air quality
  - ✓ Time of year

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Summer Patch

Ugly Kentucky bluegrass

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Gray Snow Mold

Shade = slow snow melt = more disease

Pythium Blight

Predictive Model

- **Hot weather**
  - optimal +85°Fday / +70°F night
- **Extended leaf wetness**
  - +90%RH for >10 hours
- **160 rule**
  - 90%RH + 70°F = 160 for 2 days = outbreak

Brown Patch

Rhizoctonia solani Predictive Model

- **Warm nights**
  - Soil temperature >61°F
  - Air temperature >59°F
- **Extended leaf wetness**
  - 95% RH for >10 hours
  - 0.1” rain or irrigation in preceding 36 hours

Photo: Richard Buckley, NJAES

Billbug Degree Day Model

- 50°F base temp
- Start date March 1
- 155 – 195 DD:
  - 1rst adult activity
- 311 – 347 DD:
  - 30% adult activity
  - Latest effective preventive adult treatment
- 513 – 575 DD:
  - Larvae emerge from stems
  - Begin curative control
- 739 – 825 DD:
  - Damage appears

Turf disease by season

- **Winter Diseases**
  - ✓ Red thread
  - ✓ Snow molds
  - ✓ Yellow patch
- **Spring/fall Diseases**
  - ✓ Dollar spot
  - ✓ Red thread
  - ✓ Leaf spot
  - ✓ Take all patch
  - ✓ Rust and smuts
  - ✓ Septoria leaf blight
  - ✓ Ascochyta leaf blight
- **Summer Diseases**
  - ✓ Dollar spot
  - ✓ Brown patch
  - ✓ Gray leaf spot
  - ✓ Pythium blight
  - ✓ Summer patch
  - ✓ Rust
  - ✓ Fairy rings
  - ✓ Anthracnose
  - ✓ Powdery mildew
  - ✓ Slime molds

Step 3: Evaluate the predisposing conditions

- **Evaluate management program**
  - ✓ Pruning
  - ✓ Fertility
  - ✓ Irrigation
  - ✓ Cultivation
  - ✓ Pesticide input

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Acute Heat Stress

Injury from mowing operations – grass was mowed when too hot

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Dollar Spot

Brown Patch – High N / Dollar Spot – Low N

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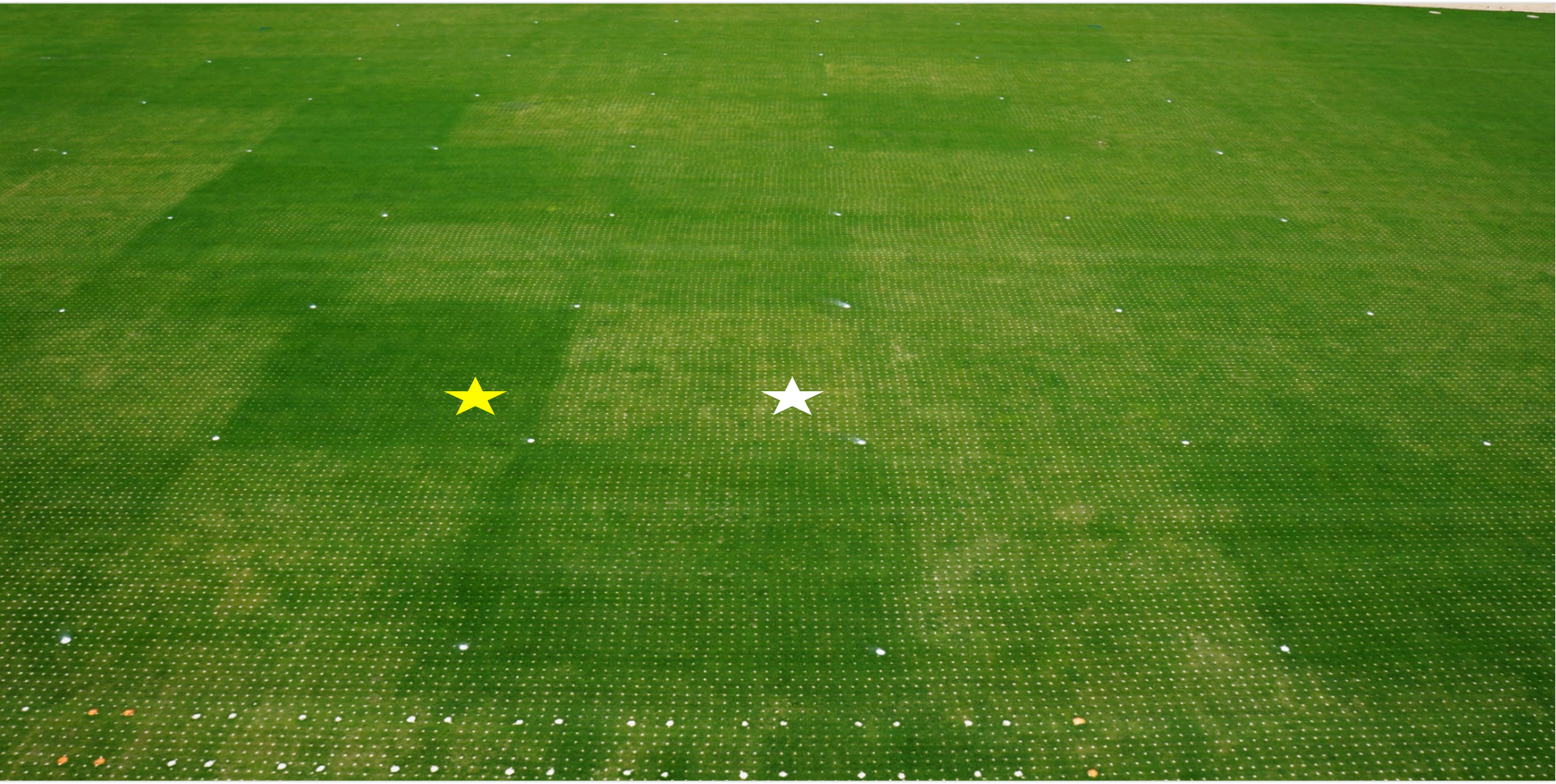
Soil pH Problems

Photo: Chas Schmid, NJAES



White star = Pale yellow *Poa annua* @ pH 5.3
Yellow star = Nice green *Poa annua* @ pH 6.3

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Heat stress

note the difference between irrigated and un-irrigated

Rapid decline after a week above 100^{o}F

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Chemical Injury

Tank mix was phytotoxic – Why is the damage worse in taller turf?

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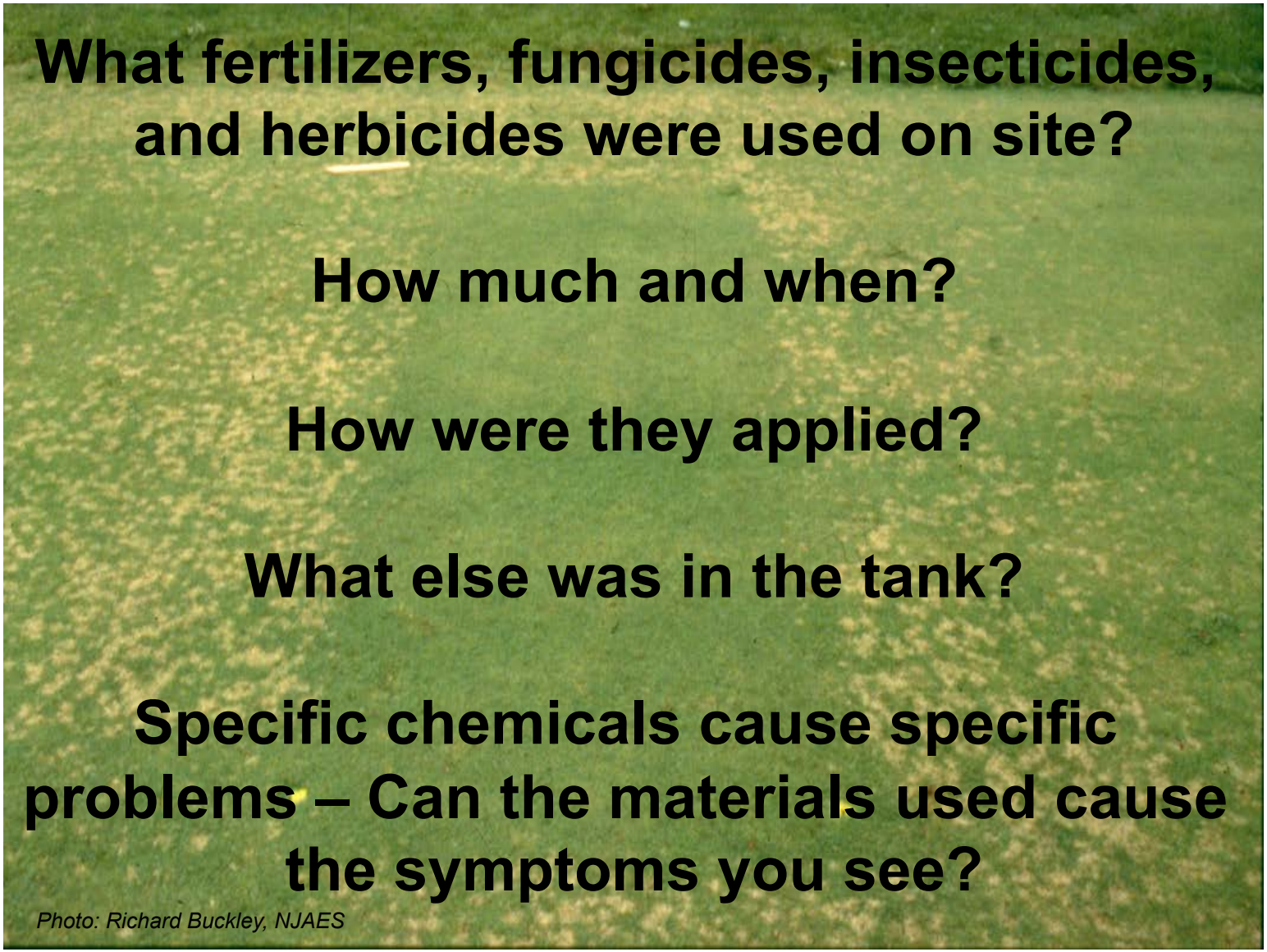
Chemical Injury



Step 4: Identify the sign

- Macroscopic observation
- Microscopic observation
- Pathogen stimulation
- Pathogen isolation
- Antibody based test kits
- Special tests

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Red Thread

pseudosclerotia “Red threads” form on leaf tips

Macroscope
Dissecting Microscope
Hand-lens

10 to- 60x Magnification

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Anthracnose

***Colletotrichum* is an excellent saprophyte and will exploit dead plants**

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Anthracnose

Fungus hastens the senescence of stressed leaves

Annual Bluegrass Weevil and Black Turfgrass Ataenius

Photo: Sabrina Tirpak, NJAES

Dissecting scope reveals spot ID characters of insects

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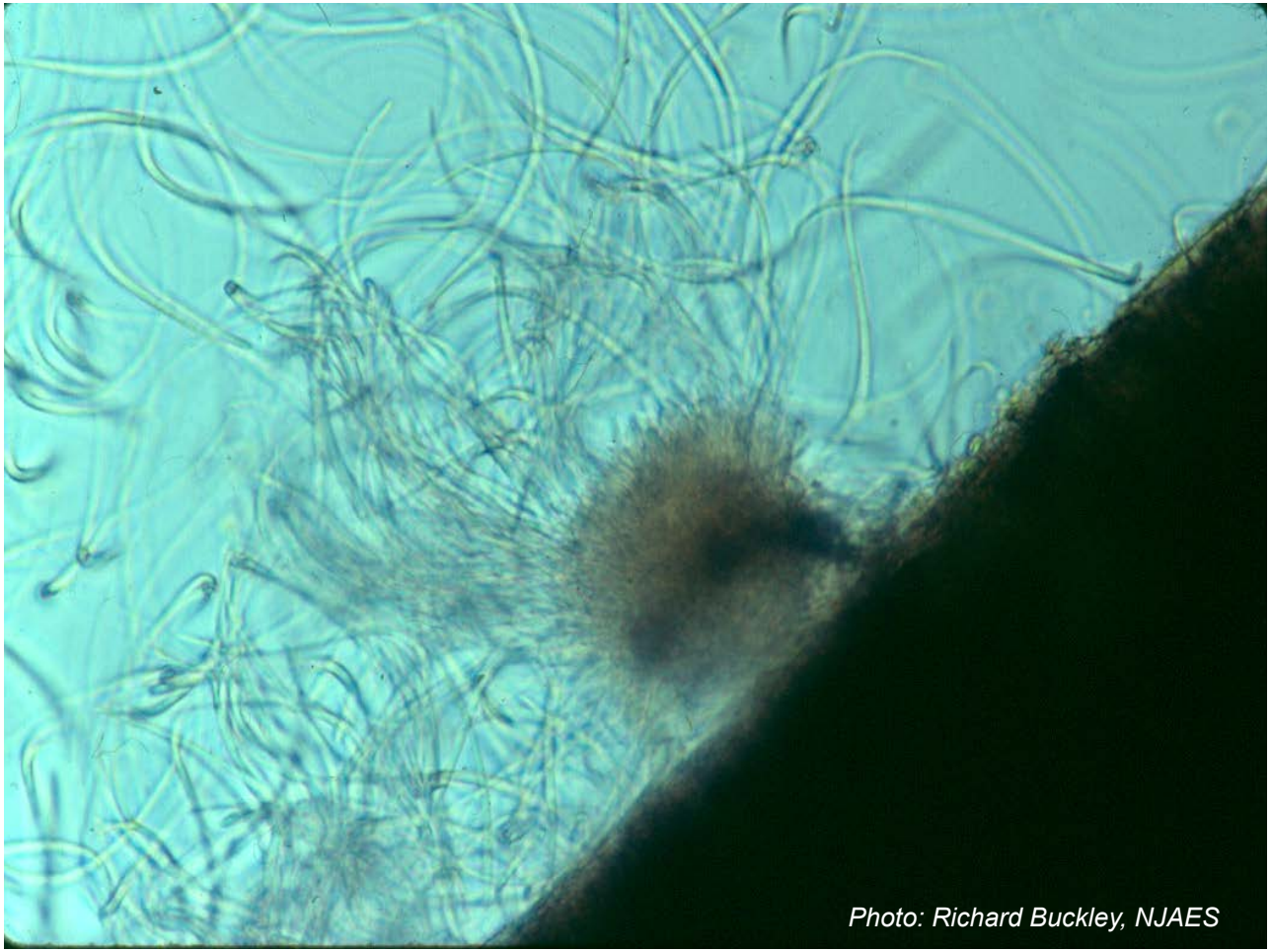
White Grub Raster

Compound Microscope

40 to- 400x Magnification

Copper Spot – *Gloeocercospora sorgii*



Note: sporodochia produce copious numbers of whip-like conidia

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Dollar Spot

Mass of mycelium grows overnight in moist chamber

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Pythium Disease Complex

Photos: Sabrina Tirpak, NJAES

Cottony blight: active mycelium during disease outbreaks
Note: fungus (brown algae) immediately reproduces!

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Diagnostic Sampling

A golf course cup changer makes an effective insect sampling tool

Photos: Sabrina Tirpak, NJAES

Float the plug in a bucket of water
Insects will float to the surface in a few minutes

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Dollar Spot

Fungicide resistance trial shows fungal growth on amended plates

Species Detection

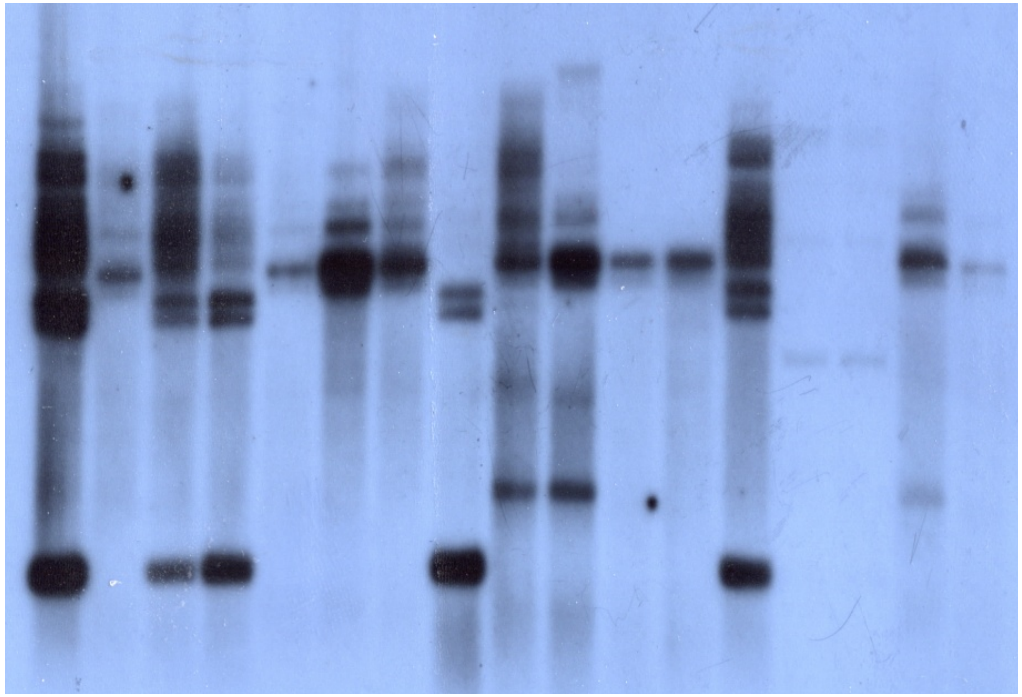


Photo: Dr. Ann Gould, NJAES

Real time PCR

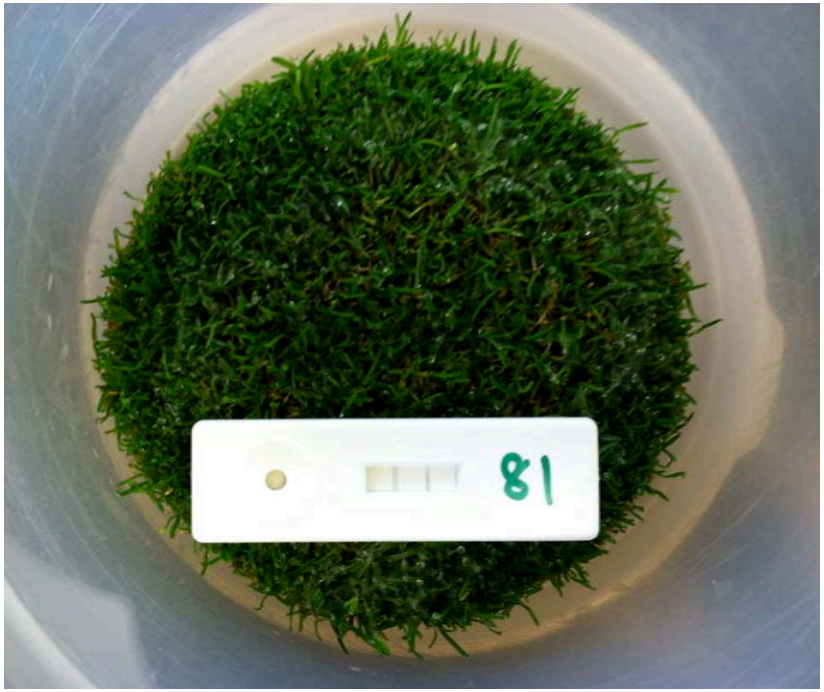
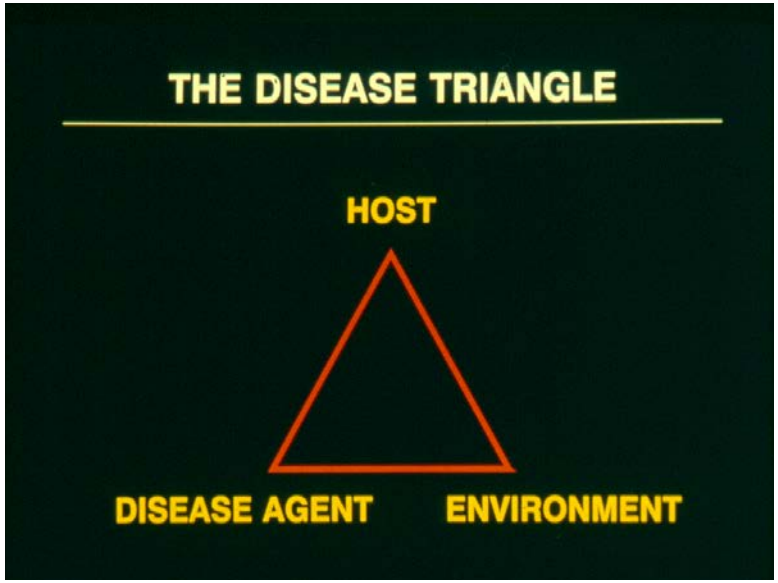


Photo: Richard Buckley, NJAES

ELISA

Step 5: Synthesize the information

- **Put it all together**
  - ✓ **Evaluate the symptoms** (host)
  - ✓ **Consider the predisposing factors** (environment)
  - ✓ **Identify the sign** (causal agent)



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Questions?

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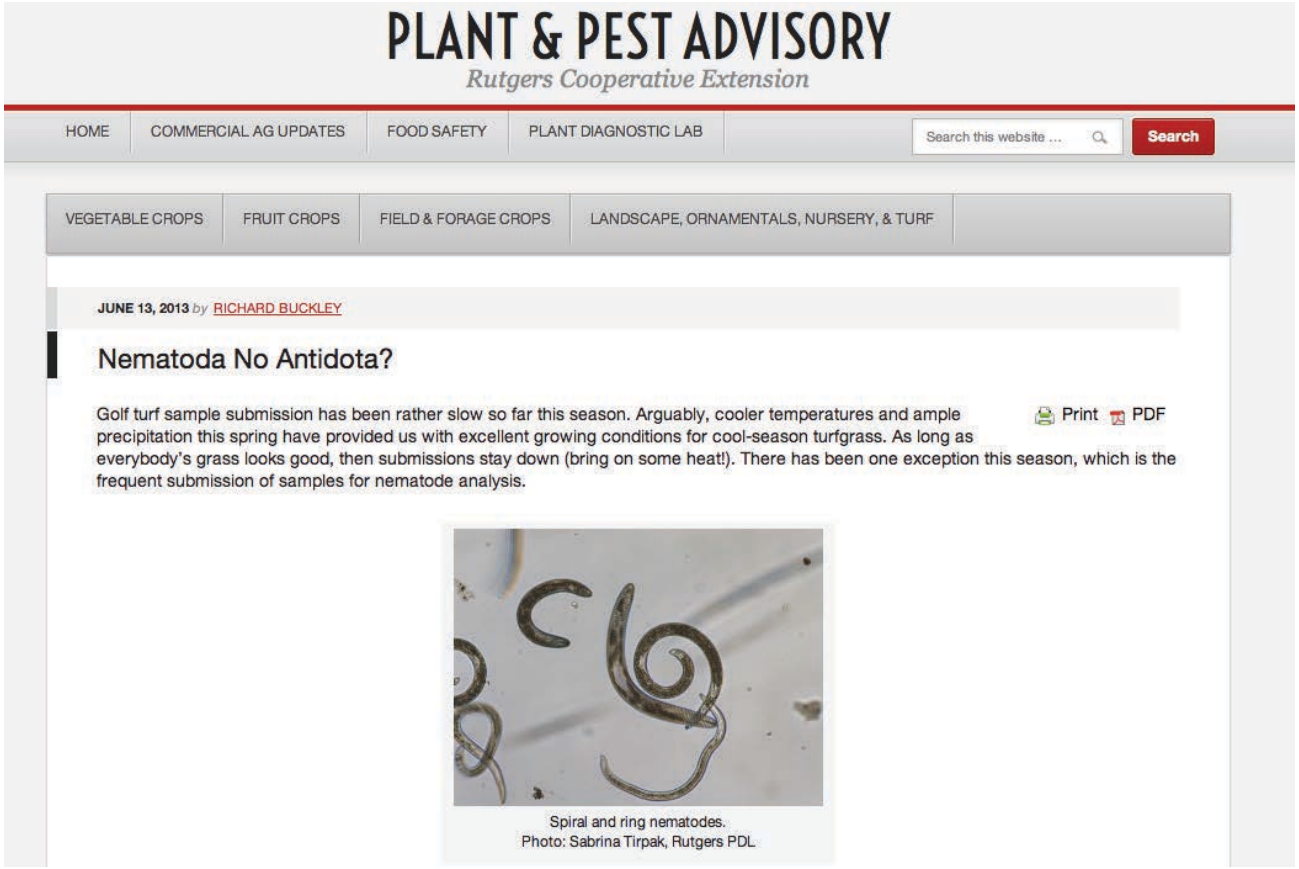

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