AGC 3342: PLANT PATHOLOGY-COMPONENT

DEFINITIONS IN PLANT PATHOLOGY

Make sure you look in the book below for any terms mentioned but not defined in powerpoint slides or handout:

Plant Pathology 5th ed - G. Agrios (Elsevier, 2005)

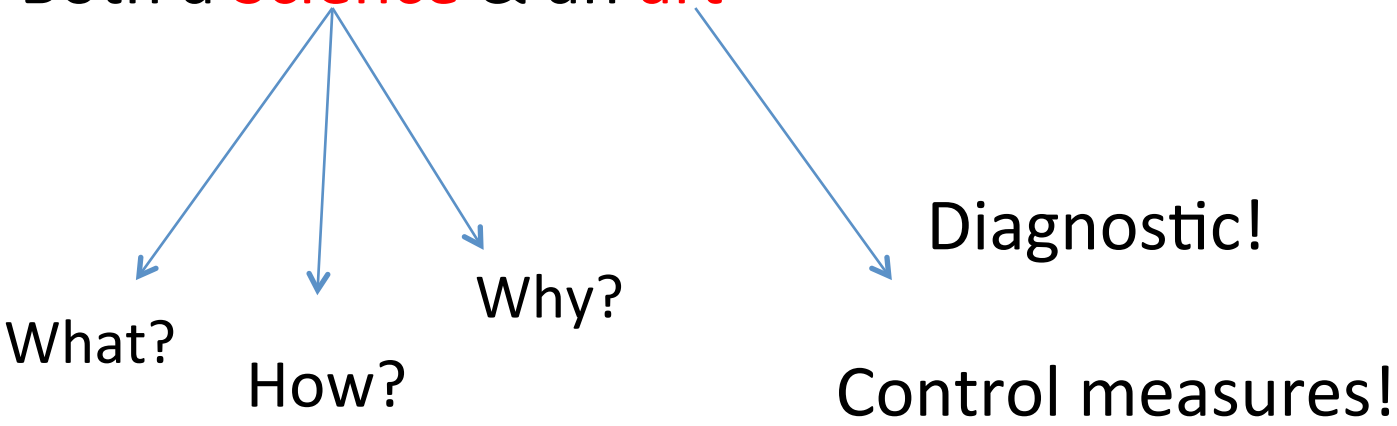
(an electronic copy of the book will be given out. Handout containing these definitions will also be given out)

PLANT PATHOLOGY

What is Plant Patho-logy?

Greek - Pathos (suffering) + Logos (study) = The study of the suffering plant

Both a Science & an art



Pathology is a study of:

1. living entities and the environmental conditions that cause disease in plants

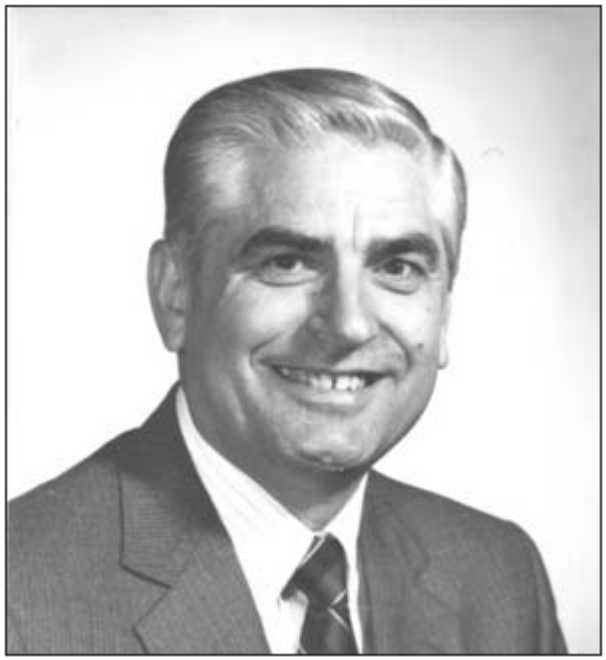
2. mechanisms by which these factors produce disease in plants

3. interactions between the disease-causing agents and the diseased plant; and

4. methods of preventing or controlling disease and alleviating the damage it causes.

Plant disease

Disease is a condition involving abnormal changes in the form, physiology, integrity or behaviour of a plant, resulting in partial impairment or death of the plant or its parts."



Agrios G.N

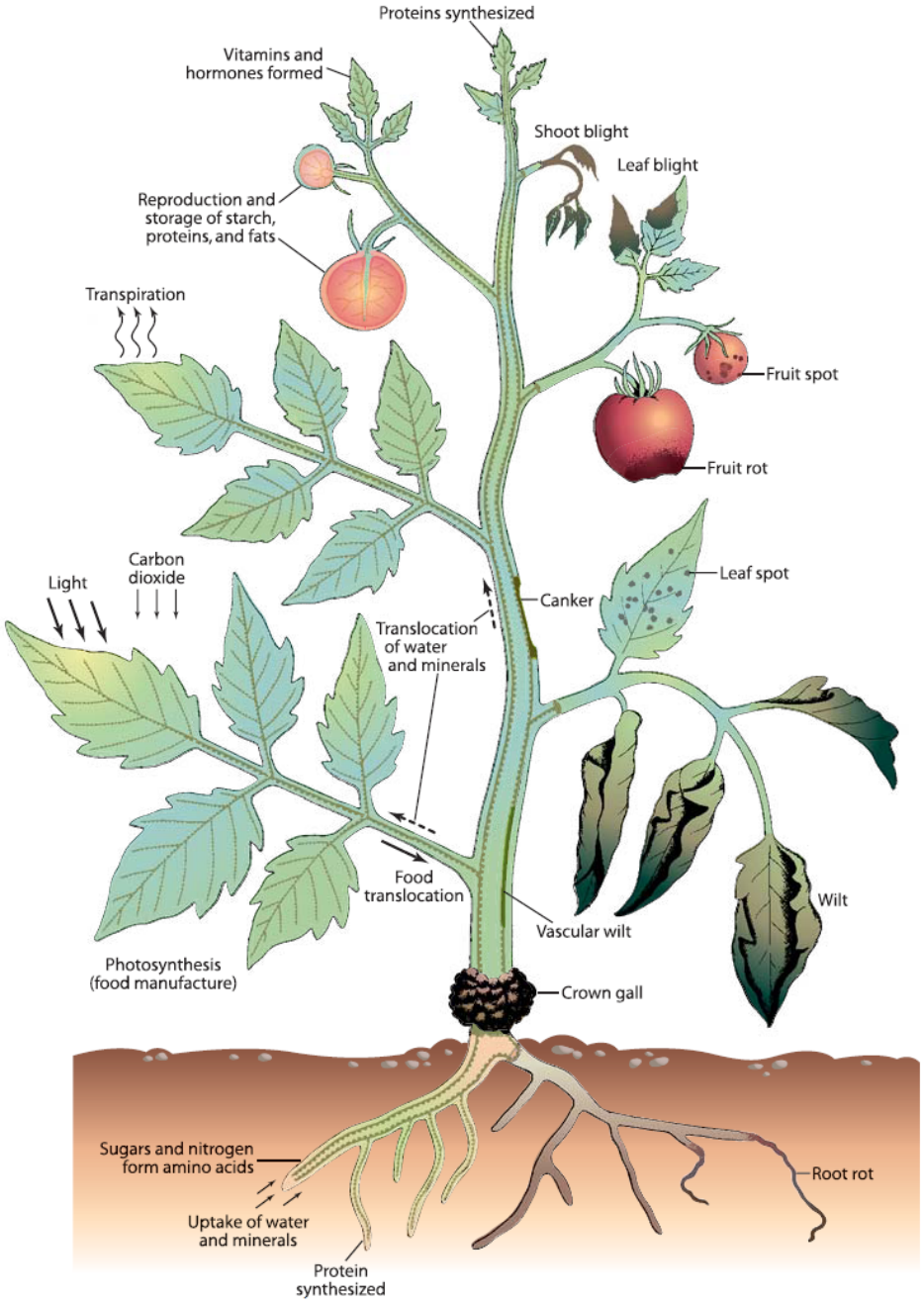


FIGURE 1-1 Schematic representation of the basic functions in a plant (left) and of the kinds of interference with these functions (right) caused by some common types of plant diseases.

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Disease is not a pathogen!!!

- Pathogens are the causal agents of disease.....

- It's wrong to say:

  "*Phytophthora infestans* is Late Blight of Potato"

Sign vs Symptom of disease

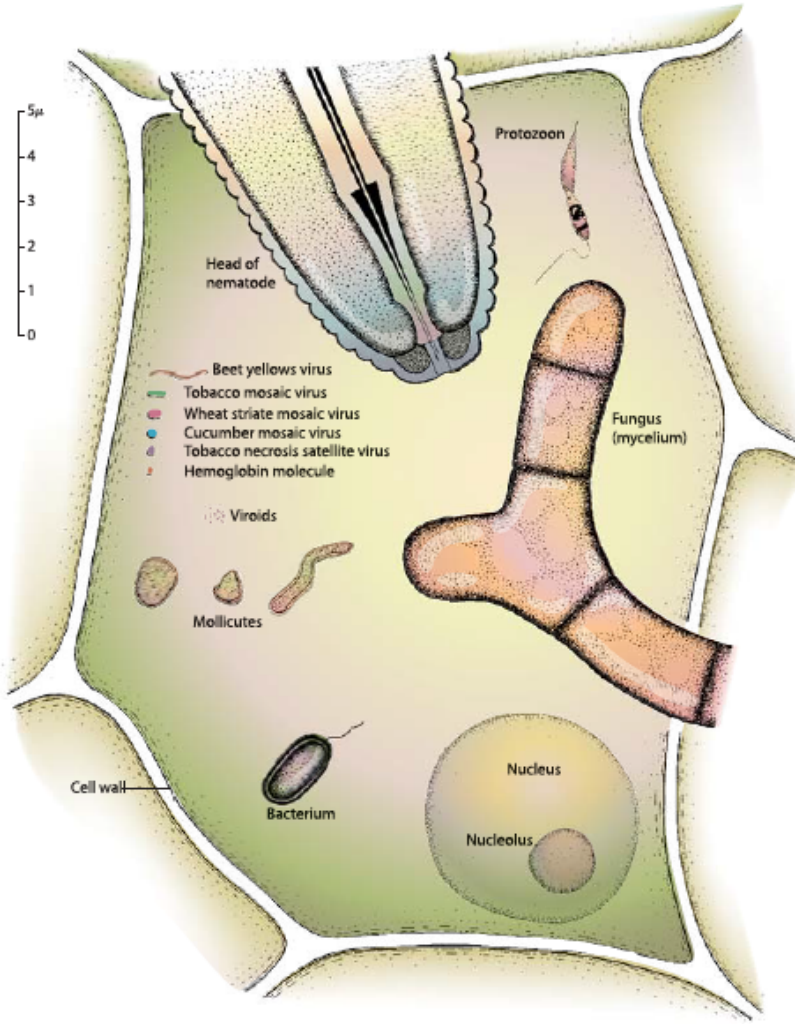
The pathogen or its parts or products seen on a host plant.

The external and internal reactions or alterations of a plant as a result of a disease

Plant pathology comprises 4 main disciplines

1. Mycology- study of fungi
2. Bacteriology- study of bacteria
3. Virology- study of viruses & viroids
4. Nematology- study of nematodes
5. Molecular plant pathology

DISEASE-CAUSING AGENTS: RELATIVE SIZES



Fungi

Bacteria

Viruses and viroids

Nematodes

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Why are plant diseases important?

1. Plant Diseases Reduce the Quantity and Quality of Plant Produce

2. Plant Diseases May Limit the Kinds of Plants and Industries in an Area

3. Plant Diseases May Make Plants Poisonous to Humans and Animals

4. Plant Diseases May Cause Financial Losses

Plant Diseases Reduce the Quantity and Quality of Plant Produce

Depending on weather, pathogen and/or host, yield loss can be up to 100%

Phytophthora infestans

Rhizopus sp

Plant Diseases May Limit the Kinds of Plants and Industries in an Area

- Some crops may not grow in certain regions of the country due to diseases.

Plant diseases may also determine the kinds of agricultural industries and the level of employment in an area by affecting the amount and kind of produce available for local canning or processing

Plant Diseases May Make Plant Products Poisonous to Humans and Animals

Mycotoxins are produced by microbial activity. These mycotoxins may end up in food and animal feed, causing diseases and even death.

Plant Diseases May Cause Financial Losses

- Farmers may have to plant varieties or species of plants that are resistant to disease but:
  - ✓ less productive
  - ✓ More costly
  - ✓ commercially less profitable than other varieties
- Costs of spraying fungicides
- Costs of refrigeration during transportation

DEFINITIONS IN PLANT PATHOLOGY

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- ✓ **Pathogen:** An entity that can cause disease
- ✓ **Pathogenicity:** the capability of a pathogen to cause disease
- ✓ **Virulent:** Capable of causing a severe disease; strongly pathogenic
- ✓ **Virulence:** the degree or measure of pathogenicity of a given pathogen; relative capacity to cause disease (Virulence is recessive-a)
- ✓ **Avirulence:** Inability of a pathogen to cause disease on a certain plant variety that carries genetic resistance (avirulence is dominant-A)
- ✓ **Disease Incidence:** the number of plants affected by a disease within a population
- ✓ **Disease Severity:** the measure of damage done by a disease

- **Inoculum (pl. Inocula):** a pathogen or its parts which can cause infection when transferred to a favourable location; the population of microorganisms introduced in an inoculation. Inoculum could either be
- **Primary inoculum:** an inoculum that survives in the field and infects a crop cultivated the following growing season (causing primary infection)
- **Secondary inoculum:** inoculum produced from secondary infection and capable of causing disease within the same growing season (causing primary infection).
- **Inoculation**: coming together of host and parasite, to introduce a microorganism or virus into host plant or into a culture medium

Spore: a specialised reproductive body in fungi (and some other organisms), containing one or more cells, capable of developing into an adult.

Hypha (pl. hyphae): a single branch of a mycelium

Mycelium (pl. Mycelia): a mass of hyphae that forms the body of a fungus.

Parasite: organism that lives in intimate association with another organism on which it depends for its nutrition; not necessarily a pathogen

Resistance: Inherent ability to resist or restrict establishment of subsequent stages of a pathogen in a host to cause disease

Susceptibility: Inability of the host to resist the effects of the pathogen. It is quite variable due to a wide range of factors which are introduced to express it.

Infection: the establishment of a parasite within a host

Invasion: The spread of a pathogen into the host

Host: A plant that is invaded by a parasite and from which the parasite obtains its nutrients

Epidemic: A disease increase in a population; usually a widespread and severe outbreak of a disease

Epidemiology: The study of factors affecting the outbreak and spread of infectious diseases.

Modern farming practices and plant diseases

✓ Under natural conditions, plants occur in mixed stands, Plant types compete for space, light, moisture and nutrients. Under these conditions – there's miniminal attack of infectious disease agents on one plant type.

✓However, modern farming is typified by:

- ➢ High plant density
- ➢ Monoculture
- ➢High fertilizer inputs
- ➢Heavy use of pesticides

High plant density increases disease pressure:

- ✓ Creates micro-climate
  - ➢ high humidity- fungal diseases
  - ➢ Contact spread
  - ➢ Continued leaf wetness

Monoculture increase disease pressure through:

- when the single genetic variant or cultivar becomes susceptible to a pathogen

High fertilizer inputs:

- increase weed populations in the current and subsequent crops

- incidence of fungal and bacterial diseases by increasing tissue susceptibility and tiller density.

- tissues become more succulent and prone to pathogen attack.

High pesticides:

- Development of resistance to the chemical by the pathogens

- Resistance in vectors of diseases

Disease triangle

Optimal combination of virulent pathogen, susceptible host and favorable environment are needed to identify true resistance

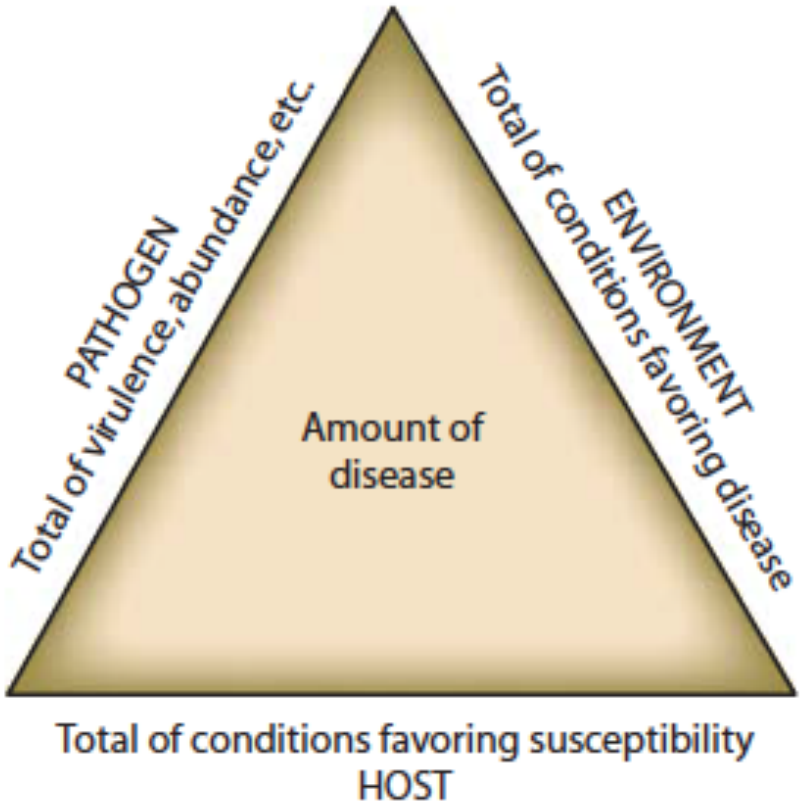


FIGURE 2-1 The disease triangle.

Agrios *et al.* 2005

PLANT DISEASE TRIANGLE

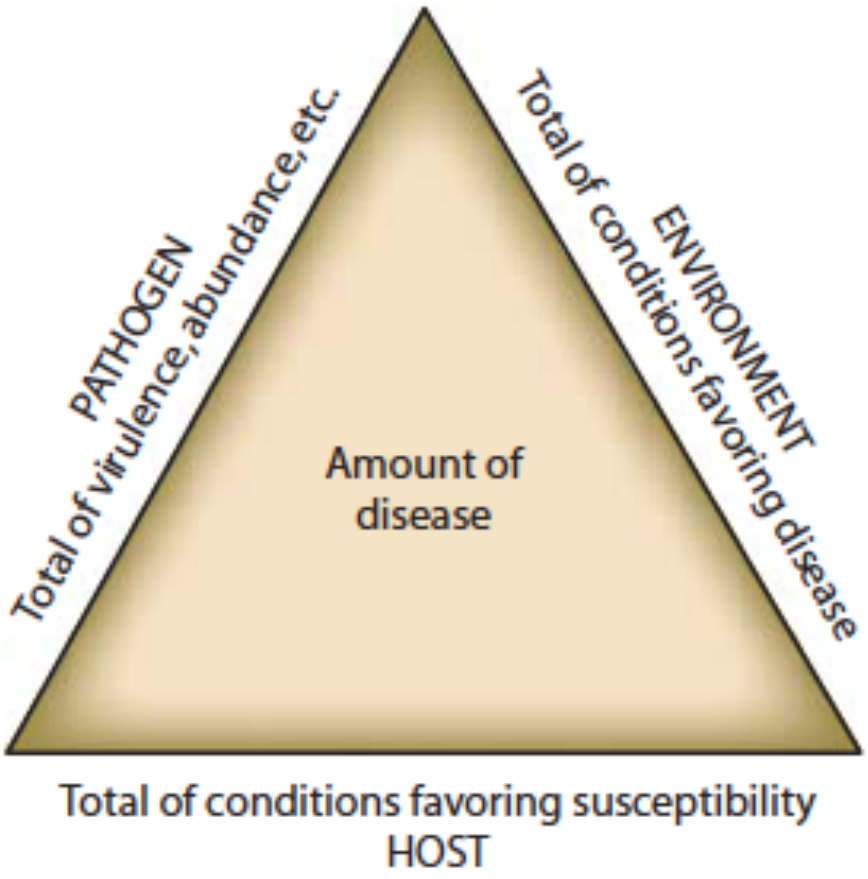


FIGURE 2-1 The disease triangle.

PLANT DISEASE TRIANGLE

1. Pathogen
2. Host
3. Environment

PATHOGEN FACTORS

- Pathogens are disease-causing organism
- Living, thus biotic
- Fungi, Bacteria, Viruses, Nematodes, Parasitic higher plants, Mycoplasmas…
- Most are host specific
- Virulent pathogens cause disease

HOST FACTORS

- A susceptible host is needed for disease to occur.
- Resistant variety is one with genetic mechanism to prevent advance of a disease.
- Could be due to physical, chemical or growth characteristics.
- May be tolerant.
- Host has to be in right stage of development for disease to occur.

ENVIRONMENTAL FACTORS

1. Moisture

- Humidity, dew, rainfall, irrigation water.
- May promote development & spread of diseases
- e.g Damping-off

2. Temperature

- Each pathogen has preferred temperature range
- Affects growth & development of the pathogen
- e.g many powdery mildews are warm temperature diseases
- May stress the plant and make predispose it to pathogen attack.

ENVIRONMENTAL FACTORS

3. Wind & Sun

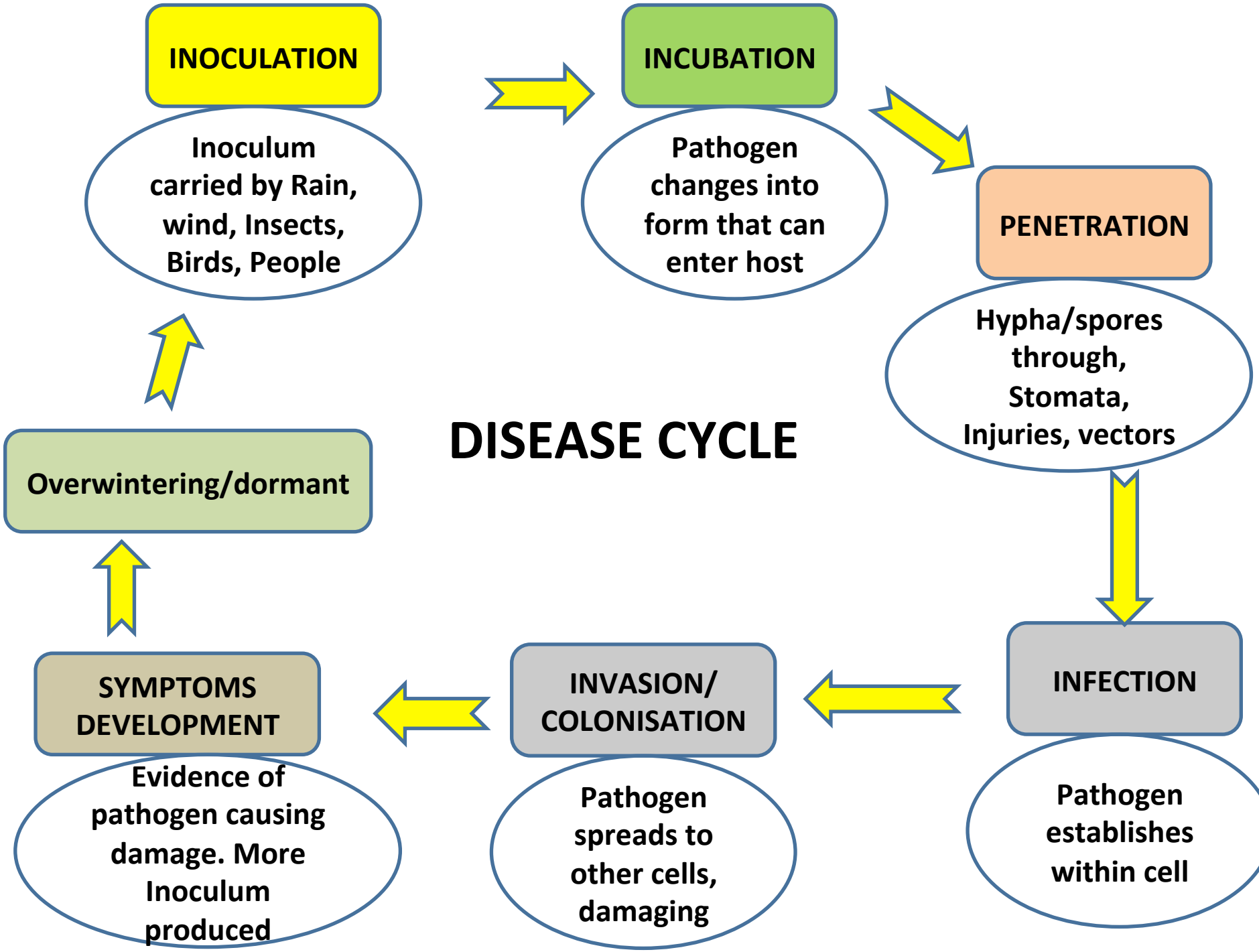
- Combination affects speed of drying on plant surfaces
- Wind can spread spores over long distances
- Inadequate sunlight lowers photosynthetic rates predisposing the plant to pathogen attack

4. Soil type & fertility

- Light sandy soil low in OM- Nematodes
- Heavy, cold waterlogged soils- Damping-off
- Acidic soils- Club root of cabbage
- Soil fertility affects plant growth rates & ability to defend themselves against diseases

Disease cycle

The chain of events involved in disease development including the stages of development of the pathogen and the effects of the disease on the host


INOCULATION
Inoculum carried by Rain, wind, Insects, Birds, People
INCUBATION
Pathogen changes into form that can enter host
PENETRATION
Hypha/spores through, Stomata, Injuries, vectors
INFECTION
Pathogen establishes within cell
INVASION/ COLONISATION
Pathogen spreads to other cells, damaging
SYMPTOMS DEVELOPMENT
Evidence of pathogen causing damage. More Inoculum produced
Overwintering/dormant
DISEASE CYCLE

HOW DO PATHOGENS CAUSE DISEASE???

1. Enzymatic degradation of the host

2. Production of toxins

3. Growth regulators: from pathogen or host

4. Genetic manipulation: viruses & some bacteria

PLANT DISEASE SYMPTOMS

- Rot
- Blight
- Leaf spot
- Streak
- Wilt
- Yellowing
- Abnormal color (e.g purple)
- Stunting
- Galls/swellings (leaves, roots, stems)
- Die-back
- Drying
- Leaf blotch/mosaic
- Blister
- Distortion (leaf/stem/root/fruit/grain)
- Little leaves
- Witches broom
- Cankers (stem lesions)
- Staining (stem/root/fruit
- Leaf fall/Fruit drop

Leaf/fruit spot – localized tissue death/ necrosis

Cercospora zeae-maydis - Grey leaf spot

Bacterial spot on tomato

caused by

Xanthomonas campestris pv. vesicatoria.

Bacterial speck on tomato

caused by *Pseudomonas syringae pv. tomato.*

Blight – widespread tissue death/ necrosis

Phytophthora infestans
(Late blight of tomato)

Bean halo blight caused by bacterium *Pseudomonas phaseolicola.*

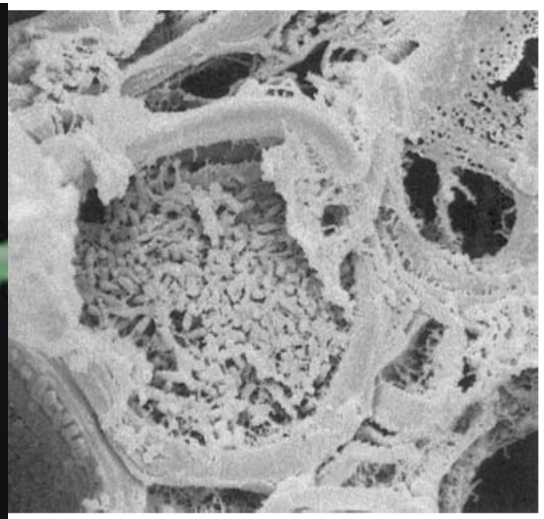
<u>Streak:</u> Band of discoloration or necrosis

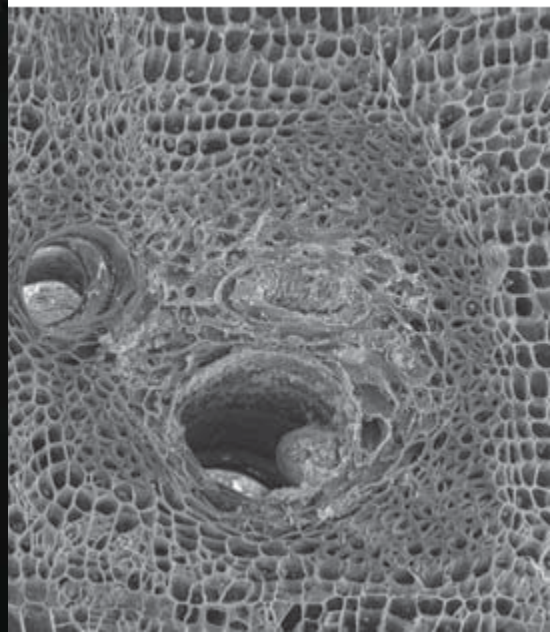
Maize streak caused by Maize streak virus

Wilt – dropping of leaves and young stems due to lack of water in them (some bacteria/ some fungi)

Ralstonia solanacearum (Bacterial wilt of potato)

https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwj1o5j1yOHjAhUPDGMBHVfiADkQjRx6BAgBEAU&url=https%3A%2F%2Fwww.infonet-biovision.org%2FPlantHealth%2FPests%2FBacterial-wilt&psig=AOvVaw3G8z2i1R9fNFAMZh0CNgVN&ust=1564745336842917





Bacterial wilt of cucurbits caused by *Erwinia tracheiphila.*

Mosaic – patchy variation of normal green color in leaves

Cassava mosaic disease caused by Cassava mosaic virus

Mosaics on tobacco leaves caused by Tobacco mosaic virus

White rot of soyabeans
(Sclerotinia stem rot of soyabeans)
Sclerotinia sclerotiorum

https://i1.wp.com/cropprotectionnetwork.org/wp-content/uploads/2018/01/Soybean-Sclerotinia-Stem-Rot-Craig-Grau.jpg?fit=640%2C480&

Rot: disintegration of tissue, often caused by enzymes or toxins produced by pathogens (bacteria/fungi)

Soft rot of peaches

Rhizopus sp

Gall: abnormal growth or swelling (some bacteria/ some nematodes)

Root galls on bean plant infected with the root-knot nematode *Meloidogyne sp.*

Root galls: tomato, carrot, potato (*Meloidogyne sp.*)

Multiple small shoots on one plant

Banana bunchy top disease - by banana bunchy top virus

Die-back

a condition in which a tree or shrub begins to die from the tip of its leaves or roots backwards, owing to disease or an unfavourable environment.

http://ucanr.edu//blogs/Topics//blogfiles/52261_original.jpg

Stunting:

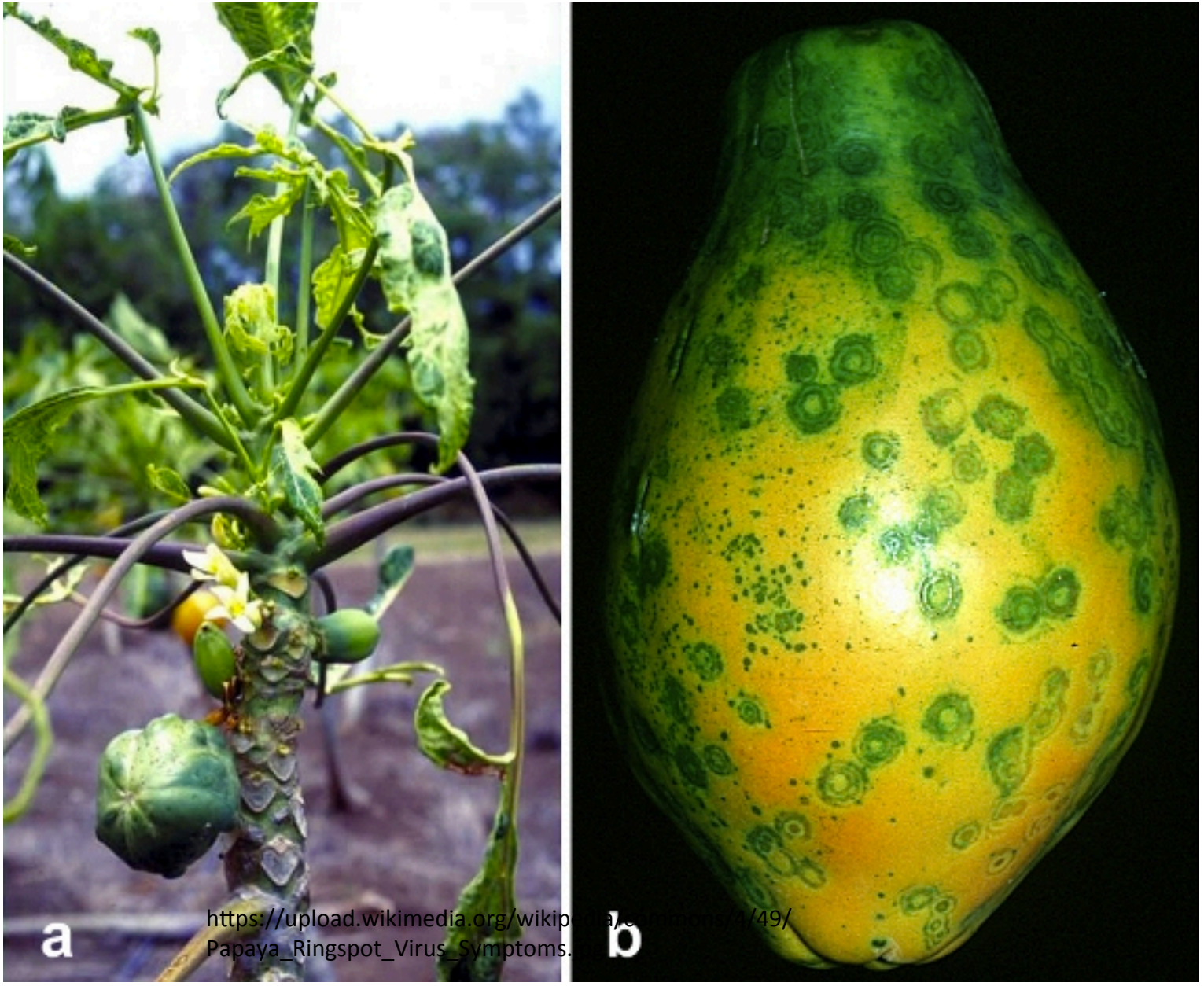
Abnormally slow growth/prevention from growth/dwarfing and loss of vigor.

Leaf edge scorch:

death of tissue along the edge of the leaf.

http://plantclinic.cornell.edu/features/featureimages/August2013/BLSelmlg.jpg

Distortion: abnormal shape in roots, leaves, fruits



https://upload.wikimedia.org/wikipedia/commons/4/49/Papaya_Ringspot_Virus_Symptoms.

Witches broom:

An abnormal brushlike cluster of dwarfed weak shoots arising at or near the same point

PLANT DISEASE SYMPTOMS

Blight	A disease characterised by widespread death of plant tissue.
Local necrosis	The necrosis sites are limited and only involves a part or a few plant cells/tissues.
Canker	A sunken necrotic lesion often of a main stem, branch or root.
Damping-off	Collapse and rot of seedlings near soil level before emergence or soon after emergence caused by *Pythium* spp., *Phytophthora* spp., *Fusarium* spp., and *Rhizoctonia* spp.
Dieback	Partial defoliation, twig and branch death and even complete death of plants.
Downy mildew	White or grey 'bloom' on leaves and stems caused by production of sporangiophores and sporangia by members of the Peronosporales (downy mildew fungi).
Gall	An abnormal growth or swelling produced as a result of pathogenic invasion.
Mosaic	Patchy variation of normal green colour in leaves, usually light and dark green mosaic, symptomatic of many viral diseases.
Powdery mildew	White powdery 'bloom' on the plant surface caused by the production of fungal mycelium, conidiophores and conidia by members of the Erysiphales (powdery mildew fungi).
Pustule	A blister-like spore mass breaking through a plant epidermis.
Rot	Disintegration of tissue, often caused by enzymes or toxins produced by pathogens.
Rust	Rust-coloured pustules formed by members of the Uredinales (rust fungi).
Scab	A discrete, superficial roughened lesion. E.g: Citrus scab – *Elsinoe fawcettii,* Powdery scab of potatoes – *Spongospora subterranea*
Smut	A disease characterised by black spore masses on leaves, stems or inflorescences, caused by members of the Ustilaginales (smut fungi).
Vascular wilt	A disease in which the pathogen is confined to the vascular system of the host and in which wilting is a characteristic symptom; plants lose their turgidity and become flaccid, leaves collapse.


SPEED
LIMIT
30
CRIME SCENE DO NOT CROSS
CRIME SCENE DO NOT CROSS
FBI
89
68
85

PLANT DISEASE DIAGNOSIS

Requires:

- Patience and carefull observation of disease symptoms, the environment, and historical activities in the field.
- May require both field and laboratory steps
- Requires knowledge of symptoms, pathogenic agents, and differences between abiotic and biotic causes of symptoms
- An understanding of control methods, and when to apply them.

PLANT DISEASE DIAGNOSIS

STEPS

1. Take a close-up view of the diseased plant
2. General view of the field and environment
3. Establish cropping and management history
4. Observe patterns/speed of spread or lack thereoff
5. Apply your knowledge of plant pathogens/diseases and consult repositories
6. Provide recommendations for control

PLANT DISEASE DIAGNOSIS

Take a close-up view of the diseased plant

- all parts, hand lens, microscopes
- Look for signs of pathogen
- Take photos and samples

General view of the field and environment

- weather, soil, cultural practices, fertiliser, chemicals

Establish cropping and management history

- Ask questions: Irrigation? Herbicide management

PLANT DISEASE DIAGNOSIS

Observe patterns/speed of spread or lack thereoff

- What else happened? rainfall? Is it spreading? Other species affected

Apply your knowledge of plant pathogens/diseases and consult repositories

- Healthy vs diseased plant; signs & symptoms; primary causes; diagnosis manuals

Provide recommendations for control

- What control method to apply? Is it necessary to act?

IS IT BIOTIC OR ABIOTIC?

- Several abiotic effects could produce symptoms
- Check to see whether these have occurred
-
- Is disease spreading? (abiotic does not spread)
- Are symptoms appearing on the same day all-over the field? (not abiotic)
- Random symptoms = biotic causes
- Uniform symptoms = abiotic causes

COLLECTING SPECIMENS

- Symptoms from live plants
- Collect samples representative of all stages of the disease symptoms
- Whole plant if possible
- Wrap specimen in dry paper
- One sample/bag