

CAUSES OF PLANT DISEASES

I. Introduction

In the last module, the disease triangle was discussed and that it represents the three conditions for a plant disease to occur. In here, every parameter will be elaborated and be given with examples as well. From biotic to abiotic factors and even the influence of time and other factors like human activities and disease vectors will be discussed. The concept of disease pyramid or tetrahedron will be explained as well as the expense of influence of each additional parameter to the relationship of the host, pathogen and environment.

Identifying these causes can help the farmer to adapt a practice that avoids these said conditions and apply a control measure and pest management to limits the damage of the already existing plant diseases,

II. Learning Objectives

At the end of this module, the students are expected to:

- 1. Discuss the Disease triangle.
- 2. Name the different parameters that can cause plant diseases.
- 3. Recall the biotic and abiotic factors that cause plant disease.
- 4. Recognize the effects of each causal factors to plants.
- 5. Explain the Disease Pyramid.

III. Pre-Test

Questions

What do you think are the causes of plant disease?

Question

Give examples of biotic factors that cause plant disease.

Question

Give examples of abiotic factors that cause plant disease.

IV. Discussion

Disease Triangle

In the case of plant disease, there are certain conditions that must be in place in order for a disease to get started. This is often simplified in a picture called the disease triangle (Figure 1). The disease triangle points out that, three favorable conditions must coexist to cause a disease problem. These three are the virulent pathogen (one that can cause disease), a susceptible host (plant) and suitable environmental conditions.



Figure 1. Disease Triangle. The three factors that have to coexist are presence of a pathogen, proper greenhouse environment for disease development and a susceptible host plant.

Pathogen

Infectious plant diseases are caused by living (biotic) agents, or pathogens. These pathogens can be spread from an infected plant or plant debris to a healthy plant. Microorganisms that cause plant diseases include nematodes, fungi, bacteria, and mycoplasmas. We also classify viruses and viroids as biotic agents because they must have living cells for reproduction and are composed of nucleic acid and protein. Some higher plants that produce seeds are parasitic on other plants and are considered to be pathogens.

There are several types of organisms that cause plant diseases. These include fungi, bacteria, viruses, nematodes, mycoplasmas and spiroplasmas. These pathogens need to be present in the greenhouse in order to set the stage for a disease problem. Shifting the focus to root disease pathogens, they can be present in the greenhouse in plant debris, weeds growing under the bench, dust coming in from a field or gravel driveway, contaminated tools, stock plants, left over plants, insects, etc.

Major Organisms Causing Plant Disease

- Fungi
 - Tiny, simple plants called molds, generally measured in microns
 - \circ No chlorophyll; depends on other organisms or plant tissues for food
 - Multiply by spores which produce threadlike filaments that enter the host directly or through natural openings
 - Get support from the host by extracting its nutrients
 - Can survive in adverse conditions through special structures (sclerotia) and infects again when favorable condition prevails
- Bacteria
 - Small, one-celled organism, measured in microns
 - Lack chlorophyll, cannot produce its own
 - Reproduced by cell division every 15-20 minutes
 - Need wounds or entry points to enter the host
 - Survive in seeds, plant debris, soil, tools
 - Spread by wind, water, insects, tools, or soil
 - Generally cause rotting of host tissues
- Virus
 - Smaller than fungi and bacteria, measured in nanometer
 - Can be seen only under the electron microscope
 - Strictly dependent on living organisms for food and reproduction
 - Their presence is generally recognized by the symptoms manifested by the host
 - Generally spread by insects, seeds, soil, nematodes, fungi, or mechanical means
- Nematodes
 - Thread-like unsegmented worms which are usually elongated and cylindrical in shape

- They may be saprophagous, predaceous, or plant parasitic depending on their sources of food
- The typical shape is a long and slender worm-like animal, but often the adult animals are swollen
- Plant-parasitic nematodes range from 250 um to 12 mm in length, averaging 1 mm, to about 15-35 um in width
- They have simple anatomy and transparent bodies
- Uses stylet to puncture plant cells
- Life cycle consisting of an egg stage, four larval or juvenile stages, and an adult stage

Host

A host is a plant that can become infected by a pathogen. Not all plants are susceptible to attack from the same pathogen as some pathogens have preference for certain plants. For example, *Thielaviopsis* typically attacks pansies, petunias, pansies, snapdragon, verbena, etc., but does not typically infect marigolds. Within the same plant species there can be differences in susceptibility to a specific pathogen. For example, *calibrachoa* that are compact and slow growing often have more issues with root disease than faster growing cultivars. Also, consider that within the same species of plants some may have been breed to have resistance to certain pathogens.

If a grower has more disease problems with a type or series of plant, they are often removed from the production schedule as they often cost more to produce due to higher fungicide application cost and plant loss. Also when these plants have disease, they introduce more inoculum in the greenhouse, putting other crops at risk.

Environment

This is the most complex of the three, but can also be manipulated to reduce root disease issues. Any environment that causes plant stress can make a plant more susceptible to a plant disease.

Abiotic Agents

- Extremely high or excessively low temperatures
- Unfavorable oxygen relation
- Unfavorable moisture conditions
- Nutrient deficiencies
- Minerals toxicities
- Air pollution; and

• Toxicity of pesticide

The main factors to consider are as follows:

• Watering

Watering is often the major concern when it comes to root disease problems. *Pythium* and *Phytophthora* are water molds and prefer a wet growing medium. Overwatering provides the best environment for these pathogens and also stresses plant roots, making them susceptible to attack. *Fusarium, Rhizoctonia* and *Thielaviopsis* also require moist media, but do not need wet growing media to thrive. Often they attack plants that are under stress, which can be triggered from overwatering.

• Temperature

Some root disease pathogens, such as *Pythium ultimum*, prefer cooler growing medium temperatures, while *Pythium aphanidermatum* prefer warm growing media. The crop itself has preferred temperature range, so if the crop is grown hotter or colder it becomes stressed and more susceptible to pathogen attack. For example, vinca prefers hot growing conditions, but if growing medium temperatures are below 75°F or 24°C, they are more susceptible to root disease pathogens.

• Air Movement

As with foliar diseases, poor air movement through the crop increases potential for root disease. Humid air stays trapped in the plant canopy, thereby reducing plant water use from the growing medium. The growing medium dries out more slowly, making it easier to overwater and therefore plants are under stress and susceptible to root disease pathogens.

• Humidity

As with air movement, high humidity slows the dry down rate of the growing medium via limited water usage by the plant and slow evaporation form the growing medium surface. If the growing medium dries out slowly, it takes more time to dry the growing medium which increases plant stress and susceptibility to root disease pathogens.

The Disease Pyramid

Some plant pathologists have elaborated on the disease triangle by adding one or more parameters. Suggested additional parameters have included humans, vectors, and time. Of these, only time is absolutely required so other elements represent special case applications.



Humans

Humans factor into the disease triangle because the influence of human activity on disease is pervasive in agriculture and, perhaps to a lesser degree, in lower input systems such as forestry and range management. Indeed, it is difficult to ignore such elements as cultivation practices that affect a pathogen's life cycle, genetic manipulation of plant hosts through breeding and genetic engineering, planting large expanses of genetically similar plant populations, and various environmental manipulations such as irrigation, greenhouses, and hydroponics. These factors can profoundly affect the occurrence and severity of a particular disease.

The argument against including humans as a disease triangle factor views domesticated plants as already having their identity intimately intertwined with husbandry and so humans already are represented implicitly in the triangle configuration. Certainly, many crops such as corn (maize) no longer exist in the wild or scarcely resemble wild relatives. Secondly, humans constitute a part of the pathosystem environment in the sense that we are external to the host-parasite interaction. Thus, regardless of our dominant influence, a view devoting a dimension to ourselves may be considered anthropocentric.

Vectors

Animal and other vectors may not be essential for all diseases but certainly play a critical role in many. Thus, vectors represent a special case for modification of the triangular relationship. In some cases, the pathogen actually multiplies within the cells of a vector and so disease transmission would be severely inhibited without this stage in its life cycle. However, if the pathogen is incapable of infecting its host without a vector, the pyramid fails to show adequately the intermediary nature of the vector in the pathogen-plant relationship by drawing a direct connection and circumventing the vector.

Time

The dimension of time has been added to the disease triangle by several authors to convey the impression that disease onset and intensity are affected by the duration that the three factors are aligned. Naturally, disease may not happen in the first instant the three parameters are aligned favorably but will occur after some duration. The demarcation between a healthy and a diseased plant is one not easily drawn. Indeed, symptoms and signs can take a good deal of time to appear but physiological events that define infection usually take minutes to hours. To show time as a vertex on a pyramid may be instructive; however, unlike the other three triangular elements, time is an invariant and unidirectional vector. Thus, illustration of time as a dimension rather than as a point on an arbitrary axis is more realistic and in fact may confer more educational value.

V. Activity

Name:	SCORE:
Course, Year and Section:	
Instructor:	
Date of Submission:	

Laboratory Exercise No. 3

CAUSAL MICROORGANISMS OF PLANT DISEASES

I. INTRODUCTION

The study of plant diseases is scientifically termed as plant pathology or phytopathology. This condition is caused by abiotic factors (which is composed of non-living, non-parasitic factors) and biotic factors (which pertains to a living, parasitic factor). Abiotic factors are usually environmental factors that affects the physiological development of the host plant and biotic factors are organisms usually composed of microorganisms like fungi, oomycetes, bacteria, viruses, viroids, viruslike organisms, phytoplasmas, protozoa, nematodes and parasitic plants. Biotic factors do not include ectoparasites like insects, mites, vertebrate, or other pests that consumes plant tissues affecting the health of the plant.

Fungi	Plasmodium CS	pore Types of mycelium	- X4	Colony	Spores
Bacteria	Morphology and	→ flagellation		Streptomyces	هـ
Mollicutes		18	Beneficiation	Spi	roplasma
Parasitic higher plants		推		The second	
	Dodder	Witchweed	Dwarf mistletoe	Broomrapes	
Viruses	Mor	phology			びこ Viroids
Nematodes	~	Adults		Protozo	a (Flagellates)

Figure 1. Biotic agents of plant diseases. (Source: G. N. Agrios, 1997)

Effect of both biotic and abiotic factors depends on the tolerance and resistance of a host plant. Causes of plant diseases are usually associated with the present organisms on or in a plant. Dead plants are usually associated with diseases caused by biotic agents, but not all microorganisms present in a diseased plant is the causal agent of the plant disease.

II. OBJECTIVES

To familiarize the causal organisms of plant diseases.

III. MATERIALS

1.	Bacterial diseases	:	Bacterial leaf blight of rice Bacterial leaf streak of rice Bacterial spot of tomato Soft rot of watermelon Stalk rot of corn Witches broom of cassava
2.	Fungal diseases	:	Rice blast Leaf blight of corn Leaf spot of corn Corn smut Corn rust Downy mildew of corn <i>Cescospora</i> leaf spot of eggplant Leaf mold of tomato Powdery mildew of cucumber Black spot of soursop Anthracnose of Papaya Gall of calamansi
3.	Nematode disease	:	Root knot of okra Root knot of pepper Root knot of tomato Root knot of peanut Root knot of broccoli

- 4. Glass/depression slides and cover slips
- 5. Watch glass
- 6. Razor blades/dissecting needles
- 7. Dropping bottles with distilled water
- 8. Compound/dissecting microscopes

IV. METHODOLOGY

NOTE: Prior in performing the activity, make sure to thoroughly clean your hands and the area or space to perform the activity.

A. Bacterial Diseases

- 1. Cut a small piece of the advancing portion of the diseased tissue with the use of a clean sharp blade.
- 2. In a clean glass slide, mount in water, put the cover slip and examine the specimen under low power objective. Observe bacterial oozes that may come out from the tissues.
- 3. Draw the signs that are observed from the disease tissues that is seen under the microscope.

B. Fungal Diseases

1. With a use of a clean sharp razor blade, scrape the surface part of the diseased plant.

- 2. In a clean glass slide, mount in water, put the cover slip and examine the specimen under the microscope.
- 3. Thinly section the advancing portion of the lesion or diseased area. Again, mount water in a clean glass slide, put the cover slip and examine the specimen under the microscope.
- 4. Note the different fruiting structures of the different fungi. Draw and label each correctly.

C. Nematode Diseases

- 1. Examine the enlarged portion (galls) of roots of the nematode-infested plants.
- 2. Compare root-knots gall with *Rhizobium* nodules (N-fixing root nodules) on the roots of leguminous plants. Draw what you have observed.
- 3. Place the root-knot infected roots in a watch glass or petri dish containing water.
- 4. Separate the tissue parts with the use of dissecting needs and examine the specimen under the dissecting microscope for any presence of nematodes.
- 5. Look for the female (enlarged, lemon-shaped) and male (needle-shaped) nematodes. Draw and label each accordingly.

V. OUTPUT

1. BACTERIA

Insert photo of the step-by-step procedure performed.

1 Motoriolo	2 Specimon
3. Placing of specimen in the materials	4. Drawing of observed organisms
Bacterial ooze	Bacterial cells

2. FRUITING STRUCTURES OF DIFFERENT FUNGI

3. A. *Rhizobium* nodules and Root-knot galls

Root nodules	Root galls

B. The female and male root-knot nematodes (RKN)

Female nematode	Male nematode

VI. ASSESSMENT CRITERIA

QUESTION:

Why all of the microorganisms associated with diseased plants are not causal agents or pathogens of plant diseases? Justify your answer.

ANSWER:

VII. REFERENCES

Name:	SCORE:
Course, Year and Section:	
Instructor:	
Date of Submission:	

Laboratory Exercise No. 4

LIST OF BIOTIC AGENTSTHAT CAUSES PLANT DISEASE

II. INTRODUCTION

Biotic factors (living and parasitic agents) are living microorganisms that causes plant diseases. Generally, they are termed plant pathogens when they cause the plants to prevent its normal functioning, growth and development. Pathogens can spread from one plant to another and may spread in and infect all types of plant tissue including leaves, shoots, stems, crowns, roots, tubers, fruit, seeds and vascular tissues.

II. OBJECTIVES

To enumerate and familiarize biotic agents that may cause plant diseases.

III. MATERIALS

- 1. Ballpen
- 2. Reference books, lectures or reliable internet sources

IV. METHODOLOGY

List down different microorganism that is indicated in the list below and describe each.

- 27 Bacteria
- 5 viruses that can
- 5Fungi
- 2 Nematode
- 2 Mycoplasma
- 2 Protozoa
- 2 Actinomycete

III. OUTPUT

Write your answer in the space provided and fill out all of the boxes.

A. BACTERIA

B.VIRUS

B. FUNGI

1	
1	
1	
1	
1	
1	
1	
	1
1	
1	
1	
1	
1	
1	
1	
1	
1	
1	
1	

D. NEMATODE



E. MYCOPLASMA

F. PROTOZOA



G. ACTINOMYCETES

VI. ASSESSMENT CRITERIA

QUESTION:

What is the importance of identifying and familiarizing the different causal microorganisms of plant disease?

ANSWER:

QUESTION:

Why are wounds being very important for the transmission of plant viruses?

ANSWER:

VII. REFERENCES

Name:	SCORE:
Course, Year and Section:	
Instructor:	
Date of Submission:	

Laboratory Exercise No. 5

LIST OF ABIOTIC AGENTSTHAT CAUSES PLANT DISEASE

IV. INTRODUCTION

Abiotic factors (non-living and non-parasitic agents) refer to external conditions of the plants. This factor cannot spread from one plant to another but can affect a large scale of plant population. Most of the abiotic diseases include nutritional deficiencies (composed of the essential elements: macro and micro elements), physical condition of the soil (structure, texture and type of soil), presence of high amount of salt, and different climatic and environmental condition like freezing, chilling, hot climatic temperature.

II. OBJECTIVES

To enumerate and familiarize abiotic agents that may cause plant diseases.

III. MATERIALS

- 1. Ballpen
- 2. Reference books, lectures or reliable internet sources

IV. METHODOLOGY

List down the different external factors affecting a plant's normal function, growth and development.

V. OUTPUT

Write your answer in the space provided and fill out all of the boxes.

ABIOTIC FACTOR	DESCRIPTION AND EFFECT

1	
1	
1	
1	
1	
1	
1	
1	
1	
1	
1	

VI. ASSESSMENT CRITERIA

QUESTION:

What is the most prominent abiotic disease-causing factor is present here in the Philippines? Give some examples.

ANSWER:



QUESTION:

How are you going to address this abiotic factor with limited resources and knowledge that most farmers have here in their production practice?

ANSWER:

VII. REFERENCES

VI. Summary

- The Disease triangle is composed of three elements, the susceptible host, virulent pathogen, and favorable environment.
- Under the parameter environment, some abiotic factors to be considered are extremely high or excessively low temperatures, unfavorable oxygen relation, unfavorable moisture conditions, nutrient deficiencies, minerals toxicities, air pollution; and toxicity of pesticide.
- Some plant pathologists have elaborated on the disease triangle by adding one or more parameters. Suggested additional parameters have included humans, vectors, and time. Of these, only time is absolutely required so other elements represent special case applications.

VII. References

Agrios GN (1972). Plant Pathology (Third Edition). Academic Press.

Divinagracia, G. G., P. M. Halos and A. D. Karganilla. (1971). Laboratory Exercises in Plant Pathology 11. Department of Plant Pathology. UPLB College, Laguna.

Labe, M. S., E. R. Fiegalan, M. L. Parugrug, A. C. Roxas, M. G. Patricio, C. R. Ocampo and J. M. Adiova. (2018). PRINCIPLES OF CROP PROTECTION Crop Protection 101 Laboratory Manual. Central Luzon State University, Center for Educational Resources Development and Series (CERDS).

Lucas G.B., Campbell C.L., Lucas L.T. (1992) Causes of Plant Diseases. In: Introduction to Plant Diseases. Springer, Boston, MA. https://doi.org/10.1007/978-1-4615-7294-7_2

Scholthof K. B. (2007). The disease triangle: pathogens, the environment and society. *Nature reviews. Microbiology*, *5*(2), 152–156. https://doi.org/10.1038/nrmicro1596

Internet Source:

https://www.pthorticulture.com/en/training-center/introduction-to-root-diseases-disease-triangle/

https://www.apsnet.org/edcenter/foreducators/TeachingNotes/Pages/DiseaseTria ngle.aspx

https://link.springer.com/chapter/10.1007/978-1-4615-7294-7_2