Unit 1
MODULE
7

PLANT DISEASE EPIDEMIOLOGY

I. Introduction

Plant disease is a common occurrence in the field. But it does not mean that when a farmer spots it, they will need to apply pesticides immediately to control it. Plant diseases can only become a threat to crop production and dealt with when it meets a certain threshold.

But the true danger to plant diseases is their capacity to become an epidemic. Epidemic spreads wide and quick and can become a fatal loss to the overall yield of crops when left on its own. That is why the need to study plant disease epidemiology is raised so that farmers can determine the conditions and factors that cause an epidemic as well as the control practices needed to execute to prevent economic losses.

This module covers the elements of an epidemic, its analysis, and control methods.

II. Learning Objectives

At the end of the unit, the student should able to:

1. Define epidemic;

2. Compare the following couplets:

   a) epidemic, epiphytotics
   b) endemic, sporadic
   c) indigenous, exotic
   d) endemic, epidemic

3. Explain the compound interest formula as used in the epidemiology;

4. Differentiate the compound interest disease from simple interest disease; and

5. Discuss the effects of amount of initial inoculum and r to disease control.

III. Pre-Test

Question

What is an epidemic?

Question

When do you think a plant disease will become an epidemic?

Question

How do you think can a plant disease epidemic controlled?

IV. Discussion

Epidemiology of Plant Disease

This module deals with study of disease development in plant population on what is termed epidemiology. Epidemiology takes into account all factors involved in diseases production.

a) plant susceptibility
b) pathogen virulence
c) the duration and intensity of the various environmental factors.

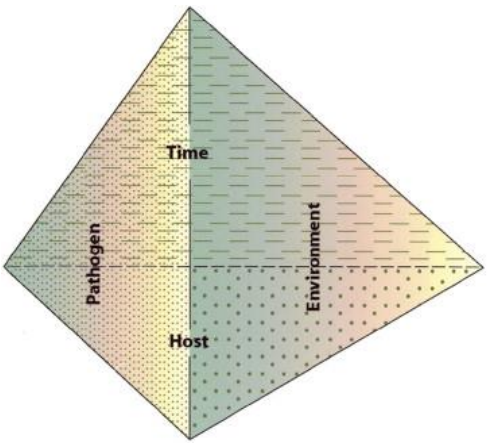
The Elements of an Epidemic

Plant disease epidemics develop as a result of the timely combination of the same elements that result in plant disease: susceptible host plants, a virulent pathogen, and favorable environmental conditions over a relatively long period of time. Humans may unwittingly help initiate and develop epidemics through some of their activities, e.g., by topping or pruning plants in wet weather. More frequently, humans may stop the initiation and development of epidemics by using appropriate control measures under situations in which epidemics would almost certainly occur without human intervention. Thus, the chance of an epidemic increases when the susceptibility of the host and virulence of the pathogen are greater, as the environmental conditions approach the optimum level for pathogen growth, reproduction, and spread, and as the duration of all favorable combinations is prolonged or repeated.

To describe the interaction of the components of plant disease epidemics, the disease triangle, and describes the interaction of the components of plant disease, can be expanded to include time and humans.

Indeed, the amount of each of the three components of plant disease and their interactions in the development of disease are affected by a fourth component: **time.**

Both the specific point in time at which a particular event in disease development occurs and the length of time during which the event it takes place affect the amount of

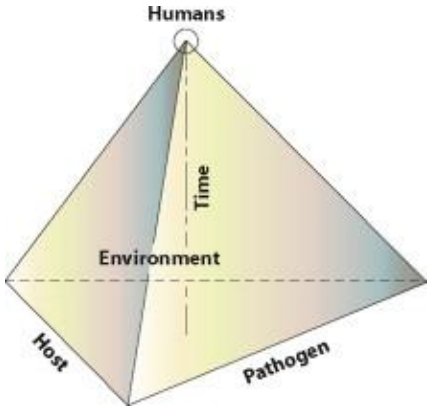


The disease tetrahedron.

disease. The interaction of the four components can be visualized as a tetrahedron, or pyramid, in which each plane represents one of the components. This figure is referred to as the disease tetrahedron or disease pyramid. The effect of time on disease development becomes apparent when one considers the importance of the time of year (i.e., the climatic conditions and stage of growth when host and pathogen may coexist), the duration and frequency of favorable temperature and rains, the time of appearance of the vector, the duration of the infection cycle of a particular disease, and so on. If the four components of the disease tetrahedron could be quantified, the volume of the tetrahedron would be proportional to the amount of disease on a plant or in a plant population.

Disease development in cultivated plants is also influenced greatly by a fifth component: **humans.**

Humans affect the kind of plants grown in a given area, the degree of plant resistance, the numbers planted, time of planting, and density of the plants. By the resistance of the particular plants they cultivate, humans also determine which pathogens and pathogen races will predominate. By their cultural practices, and by the chemical and biological controls they may use, humans affect the amount of primary and secondary inoculum available to attack plants. They also modify the effect of environment on disease development by delaying or speeding up planting or harvesting, by planting in raised beds or in more widely spaced beds, by protecting plant surfaces with chemicals before rains, by regulating the humidity in produce storage areas, and so on. The timing of human activities in growing and protecting plants may affect various combinations of these components to a considerable degree, thereby affecting the amount of disease in individual plants and in plant populations greatly. The human component has sometimes been used in place of the component “time” in the disease tetrahedron, but it should be considered a distinct fifth component that influences the development of plant disease directly and indirectly.



In figure above, host, pathogen, and environment are each represented by one of the sides of the triangle, time is represented as the perpendicular line arising from the center of the triangle and humans as the peak of the tetrahedron whose base is the triangle and height is the length of time. In this way, humans interact with and influence each of the other four components of an epidemic, thereby increasing or decreasing the magnitude of the epidemic. Sometimes, of course, humans themselves can be affected to a greater or lesser extent by plant disease epidemics.

Definition of Terms

- Epidemic
  - (Layman's view) is a wide spread, explosive disease outbreak.
  - Van der Plank (19630) – Epidemic is an increase in disease incidence within the population with time.
- Epiphytotics
  - Refer to epidemics of plant disease.
- Endemic
  - Disease is one that is native or indigenous to a particular place.
- Pandemic disease
  - It is one of worldwide or widespread occurrence throughout a cotenant or a region.
- Sporadic disease
  - Occur at irregular intervals.
- Exotic disease
  - It is one which had been introduced from some other area.

Factors Affecting the Development of Epidemics

1. Plant susceptibility

The occurrence of an epidemic requires that susceptible plants at a susceptible stage be exposed to viable inoculum of a virulent pathogen during favorable environmental condition of pathogen multiplication, infection and dissemination.

2. Pathogen virulence

The inoculum should be abundant enough, rapidly formed, vigorous, efficiently liberated, spread and inoculated. The more numerous and more efficient the vectors are, the more chances of an explosive disease outbreak.

3. The duration and intensity of the various environmental factors

All factors in the environment must favor the pathogen throughout the disease cycle from inoculation, spore termination, to penetration, to colonization, sporulation, spore liberation, and subsequent dissemination, they should also favor the multiplication and spread of vectors if there are any.

Analysis of Epidemics

The increase in the amount of disease at any one time is dependent of the following:

1. The initial amount of disease or initial inoculum

2. The rate of disease increase

3. The duration of disease increase on the period of time involved.

Repeating cycles occur with several generation of the pathogen. Simple interest diseases are those where no plant to plant spread occur during the primary cycle (only one generation occurs during the growing season). Ex. Root –diseases and vascular wilts caused by soil-borne pathogen. While compound interest diseases are those wherein the pathogens are readily spread from plant to plant during the disease cycle. Examples are rust and powdery mildews.

Van der plank has pointed out that an epidemic starts with the first diseased in the plant population. During ideal condition for diseased development, the amount of disease in a susceptible population increases logarithmically in the beginning until the remaining uninfected plant population decreases, thickly limiting disease increase. If disease incidence is therefore plotted against time, one gets a sigmoid epidemic curved.

Relation of Epidemiology to Control Practices

Most control measures are geared toward reducing the initial inoculum and or the rates of the diseases increase. The time factors is less readily manipulated although sometimes one can plant early enough in the season to escape disease or use early–maturing variety that can be harvested before a high level of inoculum has been built up by the pathogen.

Control practices that reduce the amount of initial inoculum or initial plant disease cause delay of the specific point of the time at which a given disease level is reached but they do not change the rate of disease increase. Rouging disease plants, chemical eradication, hot water treatment, destroying infected plant debris, soil fumigation, and using varieties with vertical resistance reduce the initial inoculum. The crop may still be completely devastated but at a later date.

Control measure such as modification of the environment, or cultural practices that hinder the growth and reproduction of the pathogen, and planting varieties with horizontal resistance reduce the rate of disease increase such that maturity may be reached and one may harvest before any significant damage of the crop occurs.

V. Activity

Post-Test

Test yourself about plant epidemics. Try giving your best answer.

1. A widespread, explosive disease outbreak.

(a) endemic (b) pandemic (c) epidemic

2. Native or indigenous disease to a particular area.

(a) endemic (b) pandemic (c) epidemic

3. The widespread disease occurring even worldwide.

(a) endemic (b) pandemic (c) epidemic

4. Refers to the epidemic of plant disease

(a) Epiphytotics (b) Phytopathology (c) Taxonomy

5. Disease that occurs at irregular interval

(a)Sporadic (b) pandemic (c) endemic

6. When pathogen is aggressive, this is refer to

(a) Weak (b) virulent (c) parasite

7. Disease is spread from one plant to the other

(a)Simple interest disease (b) compound interest disease spread (c) exponential

8. Epidemics require factors for their development

(a) Susceptible host (b) virulent pathogen (c) all of the above

9. There is no plant to plant spread during p[primary cycle

(a) Simple interest disease (b) compound interest disease spread (c) exponential

10. This man stated that epidemics start with first disease plant.

(a)Vander plank (b) Pasteur (c) De Barry

VI. Summary

- Plant disease epidemics develop as a result of the timely combination of the same elements that result in plant disease: susceptible host plants, a virulent pathogen, and favorable environmental conditions over a relatively long period of time.
- To describe the interaction of the components of plant disease epidemics, the disease triangle, and describes the interaction of the components of plant disease, can be expanded to include time and humans.
- The effect of time on disease development becomes apparent when one considers the importance of the time of year (i.e., the climatic conditions and stage of growth when host and pathogen may coexist), the duration and frequency of favorable temperature and rains, the time of appearance of the vector, the duration of the infection cycle of a particular disease, and so on.
- Humans affect the kind of plants grown in a given area, the degree of plant resistance, the numbers planted, time of planting, and density of the plants.
- The increase in the amount of disease at any one time is dependent of the initial amount of disease or initial inoculum, the rate of disease increase, and the duration of disease increase on the period of time involved.
- Control practices that reduce the amount of initial inoculum or initial plant disease cause delay of the specific point of the time at which a given disease level is reached but they do not change the rate of disease increase.

VII. References

GEORGE N. AGRIOS, in Plant Pathology (Fifth Edition), 2005