Plant Disease Epidemiology

Pl. Path. 111  (Cr. Hrs. 3+1)

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Epidemic

- **Slow epidemic (Tardive epidemic)**
  - Occurs in monocyclic diseases
  - On perennial plants
  - E.g. citrus tristeza; Dutch elm disease

- **Fast epidemic (Explosive epidemic)**
  - In polycyclic diseases
  - Annual crops
  - E.g. rice blast, potato blight
Epidemic & Epidemiology

- When a pathogen spreads to and affects many individuals within a population over a relatively large area and within a relatively short time, the phenomenon is called an epidemic.
  - An epidemic has been defined as any increase of disease in a population.
  - A similar definition of an epidemic is the dynamics of change in plant disease in time and space.

- The study of epidemics and factors influencing them is called epidemiology.
  - Epidemiology is concerned simultaneously with populations of pathogens and host plants as they occur in an evolving environment, i.e., the classic disease triangle.
Questions in one’s mind during outbreak of disease

- What will happen over the next few weeks?
- Will all the plants die, leaving nothing to harvest? Or
- Will only currently infected plants will yield less?
- Are all the plants infected and only few showing symptoms?
- Is the pathogen air/water/wind/vector dispersed?
- Can this crop be planted next season etc.?
Epidemiology

- Epidemiology
  - Thus epidemiology can be defined as the study population of pathogen in the population of host and the resulting disease under the influence of environmental and human factors.

- Epidemiology helps in answering entire questions by describing disease development pattern during the single season and from year to year.
Epidemics of past

- The Irish potato famine of 1845–1846 was caused by the Phytophthora late blight epidemic of potato,
- the Bengal famine of 1943 was caused by the Cochliobolus (Helminthosporium) brown spot epidemic of rice.
The disease tetrahedron

Interrelationships of the factors involved in plant disease epidemics.

- Susceptible host
- Virulent pathogen
- Favourable environment
- Development of disease is affected by
- Duration & frequency of each element of over time,
- Duration & frequency of favourable environment
THE ELEMENTS OF AN EPIDEMIC

- In fungal & bacterial diseases:
  - The Host
  - The Pathogen
  - Environment
  - Human activity
- In virus & virus like diseases
  - The Virus
  - The Host
  - The Vector
  - Environment
Factors affecting development of epidemics
Host factors

- Levels of Genetic Resistance or Susceptibility of the Host
  - Highly resistant
  - Moderately resistant
  - Susceptible

- Degree of Genetic Uniformity of Host Plants
  - Monoculture (vertical/ horizontal resistance) e.g.
    - *Cochliobolus* (*Helminthosporium*) blight on *Victoria* oats and
    - in southern corn leaf blight (Fig. 8-1) on corn carrying Texas male-sterile cytoplasm.

- Type of Crop
  - Annual
  - Perennial

- Age of Host Plants
  - Plants change in their reaction (susceptibility or resistance) to disease with age. The change of resistance with age is known as ontogenic resistance.
Change of susceptibility of plant parts with age

- In pattern I, plants are susceptible only in the stages of maximum growth (Ia) or in the earliest stages of growth (Ib).
- In pattern II, plants are susceptible only after they reach maturity, and susceptibility increases with senescence.
- In pattern III, plants are susceptible while very young and again after they reach maturity.

E.g., *Pythium* damping off and root rots, downy mildews, peach leaf curl, systemic smuts, rusts, bacterial blights, and viral infections, the hosts (or their parts) are susceptible only during the...
Pathogen factors

- Levels of Virulence
- Quantity of Inoculum near Hosts
- Type of Reproduction of the Pathogen
  - Sexual (oospores, ascospores)
  - Asexual (conidia, zoospores)
- Ecology of the Pathogen
  - Ectoparasites
  - Endoparasites
- Mode of Spread of the Pathogen
  - Active
  - Passive dispersal
Environmental factors

- Moisture
- Temperature

Effect of foliage density on development of *Phytophthora infestans* during a period of partly favorable weather (May–June) and of very favorable weather (November–December).

Human activity- a key player in modern epidemics

- Site Selection and Preparation
- Selection of propagative Material
- Cultural Practices
- Disease Control Measures
- Introduction of New Pathogens
Measurement of plant disease and of yield loss

- The disease is measured in term of:
  - Disease incidence (disease prevalence)
  - Disease severity (extent of damage to host)
  - Yield loss (the yield loss is the difference between attainable yield and actual yield)
Epidemic decline

- Saturation of the pathogen in the host population
- Decline of proneness of the host
- Reduction in aggressiveness of the pathogen
- No new infections
- Repeated infections of the host etc.
PATTERNS OF EPIDEMICS

- Interactions among the elements of epidemics, as influenced over time by factors of the environment and by human interference, are expressed in patterns and rates.
  - disease–progress curve
  - Disease gradient curve
Disease progress curve

The progress of an epidemic measured in terms of the numbers of lesions/ the amount of diseased tissue, or the numbers of diseased plants plotted over time is called the disease–progress curve.

- (A) Saturation type of curve
  - Three monocyclic diseases of different epidemic rates.

- (B) Sigmoidal curve
  - Polycyclic disease, such as late blight of potato.

- (C) Bimodal curve
  - Polycyclic disease, such as apple scab, in which the blossoms and the fruit are infected at different, separate times.
Disease gradient curve

The progress of an epidemic measured in terms of changes in the number of lesions/the amount of diseased tissue, and the number of diseased plants as it spreads over distance, is called disease gradient curve (spatial pattern).

- **disease-gradient curve**: The percentage of disease and the scale for distance vary with the type of pathogen or its method of dispersal.
  - being small for soil borne pathogens or vectors and
  - larger for airborne pathogens.
NEW TOOLS IN EPIDEMIOLOGY

- Molecular Tools
- Geographic Information System
- Global Positioning System
- Geostatistics
- Remote Sensing
- Image Analysis
- Information Technology
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