



Factors Affecting Disease Development

Sanjeev Kumar

Plant Pathology



Disease Triangle & Disease Tetrahedron

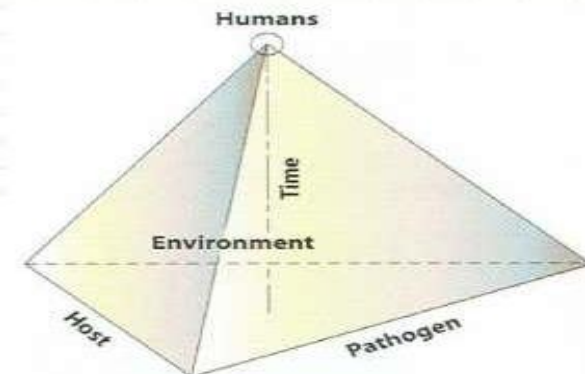
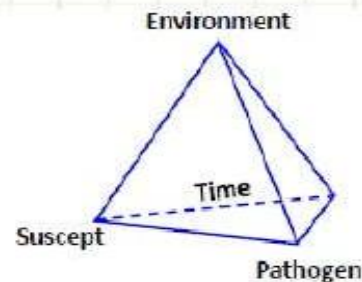
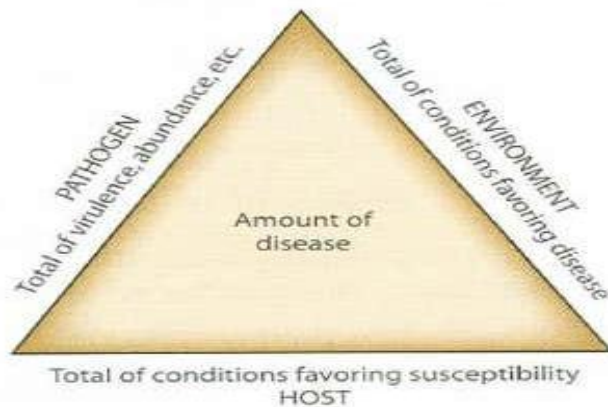
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Disease Triangle:

- Interactions of the 3 main components are described by the 1. Host 2. Pathogen 3. Environment is **disease triangle**.

Disease Tetrahedron

- Disease development is also affected by 4. Time 5. Humans
- Interactions of the 5 components are described by the **disease pyramid**.



Disease Triangle

Disease
Tetrahedron



Factors affecting disease development

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Pathogen	Host	Environment
Presence of pathogen	Type of crop	Temperature
Mode of dispersal of pathogen	Degree of genetic uniformity of host plants	Rainfall / Dew
High birth rate of pathogen	Genetic make-up	Leaf wetness period
Low death rate of pathogen	Host age	Soil properties
Survival efficiency	Host nutrition	Wind
Reproductive fitness	Host population structure	Fire history
Adaptibility of pathogen	Nature of propagation	



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a. Type of crop:

- Epidemics generally develop much more rapidly in annual crops (cereal. pulses, oilseeds and vegetable crops) than perennial crops (fruit and forest trees).
- Some epidemics of fruit and forest trees, for instance, pear decline, tristeza in citrus, Dutch elm disease and chestnut blight , takes year to develop.

b. Degree of genetic uniformity of host plants:

- Severe plant disease epidemic may develop when genetically uniform plants are grown over large area,
- Greater likelihood exists that a new pathogen race will appear that can attack their genome and result in an epidemic.
- Lowest rates of epidemic development generally occurs in cross pollinated crops, intermediate rates in self pollinated crops and the highest rates in vegetatively propagated crops.



c. Level of genetic resistance or susceptibility of the host:

- Vertical and horizontal resistance have distinct bearing on development and progress of epidemic.
- Hosts plants carrying horizontal resistance will probably become infected, but the rate at which the disease and the epidemic will develop depends on the level of resistance and the environmental conditions,
- Host plants carrying vertical resistance do not allow a pathogen to become established in them, and thus no epidemic can develop.

d. Host age:

- Plant change in their susceptibility to disease with age.
- For instance, Damping off and roots rots, downy mildews, peach leaf curl, rusts, smuts, bacterial blights and viral infections, the host plants are susceptible only during their growth period and becomes resistant during adult stage.
- In some other diseases such as flower or fruit blights caused by fungal pathogens like *Alternaria*, *Penicillium*, *Glomerella* and *Monilinia* and in all post harvest infections, plant parts(fruits) are resistant during growth and early adult stage but become susceptible near ripening.



e. Host nutrition:

1. Balanced nutrition is required for proper growth and development of plants.
2. Under good nutritional conditions, biotrophic fungi have a relative advantage;
3. Under poor nutritional conditions necrotrophic and perthotrophic fungi have a relative advantage.
4. The type and amount of fertilizers have influence on the development of plant diseases.

f. Host population structure:

1. Crop rotation and sequence and crop density have major bearing on the type and amount of plant diseases.
2. High crop density will influence microclimate and will make infection and dispersal of inoculums more effective.
3. Both these factors will help the development of disease.

g. Nature of propagation:

1. Nature of propagation affects the development of disease.
2. Chances of disease are more if plants are vegetatively propagated.



2. Pathogen factors

a. Level of virulence:

- Virulent pathogens capable of rapidly infecting the host ensure faster production of larger amounts of inoculums,
- and thereby, disease, than pathogens of lesser virulence.

b. Mode of dispersal of pathogen:

- Rapid and easy dispersal of the pathogen inoculums from its source to healthy hosts in the field may help frequent and wide spread epidemic.
- Epidemics of diseases like mildew, rusts and leaf spots occur usually as the spores of their pathogen are released into the air and get disseminated quickly by it over distances up to several miles.
- Contrary to it, soil borne pathogens like *Fusarium*, *Verticilium*, etc., and most nematodes usually have 2 to 4 reproductive cycles per growing season.
- Since, the dispersal of such pathogens is limited both in space and time, only localized and slower developing epidemics are caused.



Pathogen factors

c. **High birth rate of pathogen:**

1. High birth rate or fast reproductive cycle of pathogen is key factor for establishment and development of epidemics.
2. Some fungal pathogen have capacity to produce enormous quantity of spores asexually and these spores,
3. if dispersed fast over long distances and favored by conducive weather conditions, can result in epidemics in their respective areas.

d. **Low death rate of pathogen:**

1. Epidemics attributed to low death rate of pathogens are those in which the causal organism is systemic and protected by the plant tissues.
2. Thus, the chances of high mortality are considerably reduced and ultimately greater chance of widespread infections in a given area exist.

e. **Adaptability of pathogen:**

1. For pathogens having capacity to acclimatize to adverse conditions, the occurrence of epidemics is about certain.
2. The units of propagules produced by the pathogen are dispersed by external agencies which must be available if epidemics are to develop.



- This includes the aerial environment and the soil (*edaphic*) environment.

i) **Aerial environment**

- **Properties of the aerial environment that influence disease development include, temperature, moisture levels and pollution.**

a) **Temperature:** Temperature affects

- **Incubation, or latent, period (the time between infection and the appearance of disease symptoms),**
- **Generation time (the time between infection and sporulation),**
- **Infectious period (the time during which the pathogen keeps producing propagules).**

- **Disease cycle speeds up at higher temperatures, resulting in faster development of epidemics.**
- **The period of leaf wetness, combined with temperature information can be used to predict outbreaks of some diseases (infection periods) and be used to time preventative treatments, such as spraying.**

b) **Moisture:**

1. **Important to pathogenic bacteria and fungi.**
2. **Rain splash plays an significant role in the dispersal of some fungi and nearly all bacteria,**
3. **Period of leaf wetness is essential for the germination of most air borne spores.**
4. **By using water for dispersal, propagules are dispersed at a time when they**



Elements of an Epidemic

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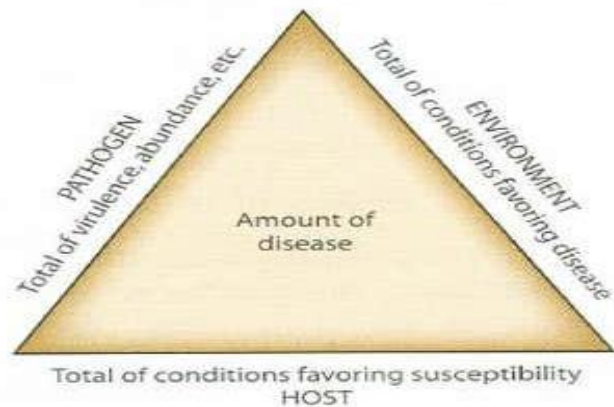
1.Host2. Pathogen3. Environment

Interactions of the 3 main components are described by the **disease triangle**.

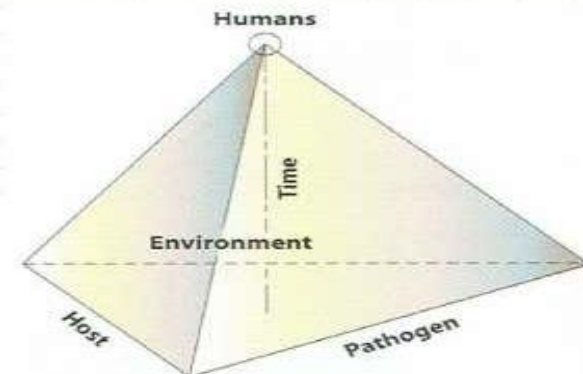
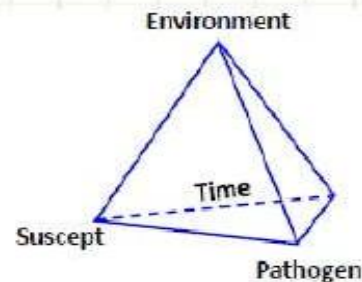
Disease development is also affected by 4.Time 5. Humans

Disease Tetrahedron

Interactions of the 5 components are described by the disease pyramid.



Disease Triangle



**Disease
Tetrahedron**



Genetic resistance or susceptibility of Host

- Vertical Resistance
- Horizontal Resistanceii.

Degree of genetic uniformity of host in a particular field

- Monoculture, especially Clones
- Natural, Intermingled Populationsiii.

Type of crops

- Annual crops & foliar or fruit diseases develop muchmore rapidly (in weeks)
- Perennial woody diseases take longer time to develop(in years)iv.
- iv. Age of host plants
- Some plants are susceptible only during growth period& become resistant during mature period

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How the Plant Affects Development of Epidemics



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How Pathogens Affect Development of Epidemics

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i. Levels of virulence

- Faster Production of Larger # Inoculum

ii. Quantity of inoculum near hosts

iii. Type of reproduction of the pathogen

- Monocyclic
- Polycyclic
 - Responsible for most Sudden, Catastrophic Epidemics
- Polyetic

iv. Ecology of the pathogen

- Reproduce on Surface of Aerial Parts of Plant
- Reproduce inside Plant
- Reproduce on Infected Plant Parts in Soil

v. Mode of spread of the pathogen

- Breezes or Strong Winds
 - Most Sudden & Widespread Epidemics
- Inoculum Carried by Airborne Vectors
- Wind-Blown Rain
- Carried on Seed, Tubers, Bulbs
- Beetles
- Pathogens Spreading through Soil
 - Usually Local, Slow-Spreading Diseases of Considerable Severity



3. Environmental factors

i. Moisture

- Rain, dew, high humidity
- Dominant factor in diseases caused by oomycetes, fungi, bacteria & nematodes

ii. Temperature

- Affects disease cycles of pathogens

Disease development is also affected by

4. Time factors

- Season of the year
- Duration & frequency of favorable temp. & rains
- Appearance of vectors, etc.

5. Humans Affect

- Site Selection & Preparation
- Selection of propagative material
- Introduction of exotic pathogens
- Cultural Practices
- Disease control measures
- Introduction of new pathogens or disease