Disease development in populations of plants

- How fast? *speed*
- How many? *efficiency*
- How far? *movement*

Review:

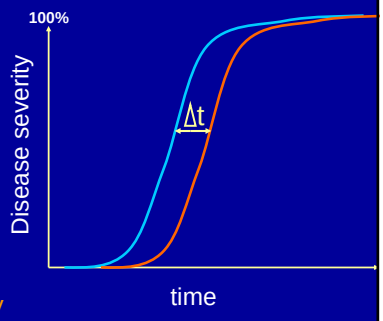
- A *contagious*, polycyclic disease epidemic is typically described by an S-shaped 'DISEASE PROGRESS CURVE' (initially exponential, then a linear (logistic) mid-phase, then a slowing terminal phase)
- The overall speed (steepness) of the curve can be summarized by an infection rate parameter, 'r', which is a potential birth rate of new disease. (units = % per day)
- The magnitude of 'r' is influenced equally by each component of the disease triangle (H, E, P)
- A high value of 'r' rate greatly lessens the benefit obtain from sanitation of primary inoculum
- Reducing 'r' results increases the value of sanitation

Review: For polycyclic diseases, reducing primary inoculum with sanitation not always a tremendous value

Second curve was generated after an 80% reduction in primary inoculum.

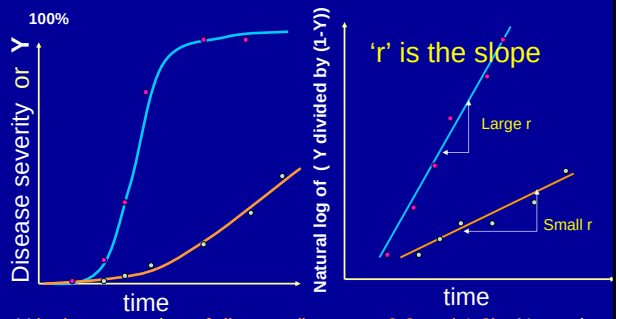
Result: Disease progress was delayed by 8 days

Assumes 'infection rate', *r* = 0.2 per day



Estimation of the infection rate, r

1) Measure disease over time 2) Visualize graphically 3) Transform data & compute slope



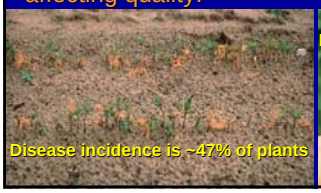
Y is the proportion of disease (between 0.0 and 1.0). Natural log of (Y divided by (1.0 -Y)) is known as the logit transformation

Measuring Disease

Two methods:

Incidence (yes or no?)
Proportion of diseased units (leaves, plant, fields) to total number of units.
Common for systemic diseases and those affecting quality.

Severity (how bad is it?)
Proportion of plant tissue diseased relative to total susceptible tissue.
Common for foliar diseases, especially those impacting yield



Questions:

- Is incidence? or severity? a better choice of measurement for a *systemic disease*.
- Is incidence? or severity? a better choice of measurement for a *leaf spot disease*.
- Can we draw a disease progress curve using incidence measurements?
  and severity measurements?

How fast is disease increasing?

Polycyclic: $r = \sum_{P}^{E} \triangle I_{H}$

Speed (at any point) = potential infection rate, r X amount of contagious tissue X amount of healthy tissue

What does the curve look like?

Monocyclic:

Speed (at any point) = potential infection rate, r_m X pool of inoculum from another season (or place) X amount of healthy tissue

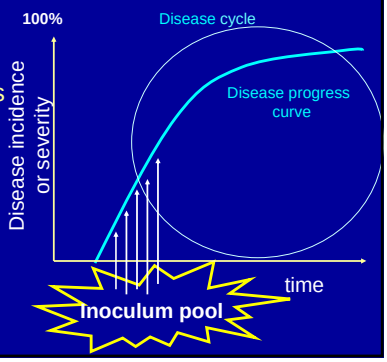
What does the curve look like?

Monocyclic disease progress curve in a population of plants

One disease cycle is turned per season, but timing of infection among individual plant units can vary.

Over time, multiple infections on same plant unit slows the apparent rate of disease increase.

The shape of the curve (inverted 'J') represents a 'saturation process'

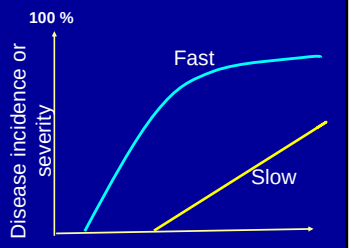


Monocyclic diseases can be managed effectively by reducing the rate of infection **AND** **by reducing the amount of primary inoculum**

Methods:

Reduce infection rate:
modify environment
host resistance

Reduce inoculum pool



Speed = infection X inoculum
rate pool
1 : 1

Questions?

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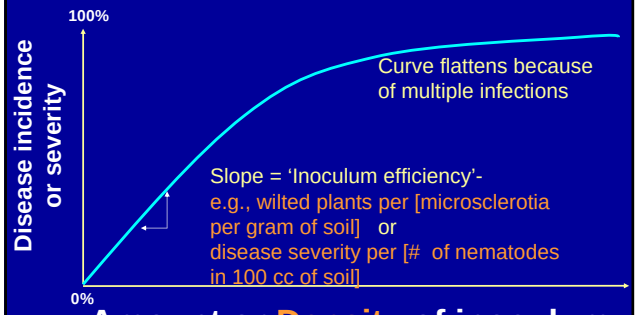
Question:

How many of infectious propagules (spores, cells, resting structures) are required to obtain an infection?

-- in theory?

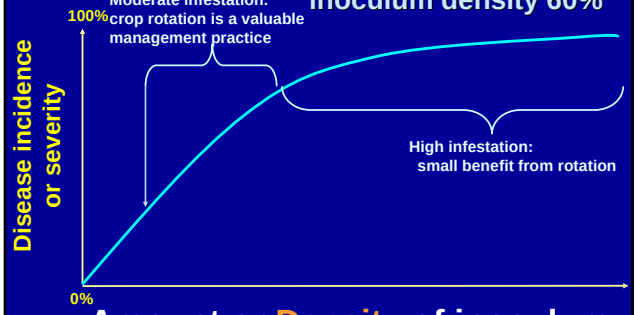
-- in practice?

How Many? Another type of saturation process



Practical significance of How Many

Example: Crop rotation reduces inoculum density 60%



Disease development in populations of plants

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Question:

How far does an infectious propagule (spore, cell, resting structure) move during a dispersal event?

--average propagule?

--farthest dispersed propagule?

How Far?

Disease distribution in spatial dimensions

The curve at right is called a '**disease gradient diagram**'.

It depicts intensity of disease measured over distance, and characterizes the potential for disease spread.

The existence of a 'gradient' (decreasing intensity of disease over distance) implies a local source of inoculum.

Mechanisms of dispersal (rain splash, wind, equipment, water) greatly influence the shape and scale of the disease gradient