

TRANSMISSION AND SPREAD OF DISEASES AND ARTHROPOD PESTS

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Outline

- Definitions
- Methods of transmission/spread of diseases
- Methods of spread of insect pests

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Definitions

- **Transmission:** ability to pick up a pathogen from one plant and pass it on to another plant. Insects /nematodes have that ability to obtain, carry and deliver a pathogen which without the presence of insects would not have been able to move
- **Spread:** movement from an infected/ infested plant /area to a non infected plant or area
- **Prevention:** keep from becoming a problem
- **Suppression:** reduce its increase and effect on the host plant
- **Eradication:** use various methods and destroy pests

Introduction

- Most crops are subject to damage by pests and diseases
- All parts are affected and the genetic potential is interfered with
- All plant parts are damaged : seeds, roots, stems, leaves and fruits
- When plants are affected there is reduced plant vigour and in some cases plant death and crop loss occurs

Introduction

- Plants cannot move from one place to another except by being swayed by wind side to side
- Diseases and pests affecting plants must therefore be brought in to infect or infest (primary inoculation)
- Diseases and pests must have a way of moving from plant to plant within the field (secondary infection)
- There are different modes of movement of these pests and diseases

Modes for movement of pests and diseases

- Wind (weed seeds, fungi, insects/mites)
- Seed (weed seeds, fungi, bacteria, viruses, nematodes)
- Infected soils : with fungi, bacteria, nematodes or larval or pupae stages of an insects
- Rain splash /hailstorms (bacteria, fungi, nematodes)
- Infected irrigation water (fungi, bacteria, nematodes)

Modes for movement of pests and diseases

- Farm implements (soil, plant parts, left over seeds)
- Movement of vegetative plant parts
- Animals (birds, mammals (hair/fur), rodents)
- Man (trade, movement of seed, insects on farm working cloths, weed seeds attaching on cloth, shoes /boots from one field to another)

Dispersal

- Dispersal of pathogen, pollen, and seed
 - Pathogen: effective dispersal depends on traits of spores (size, moisture, UV susceptibility) and threshold number needed for infection
 - Longer movement sometimes through stepping stones
 - Usually infection shows patterns of aggregation (clustering). It is an easy way to show infectious disease

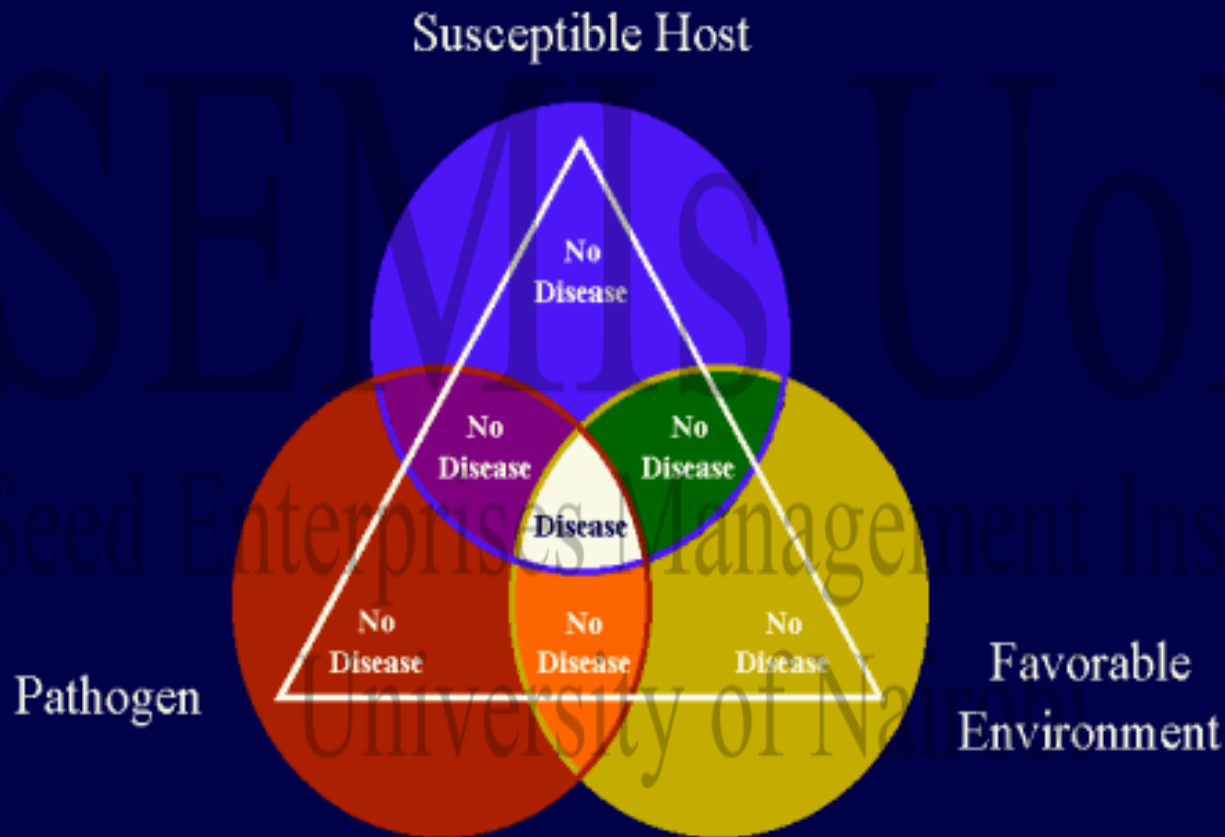
Determinants of spread

- Amount of inoculum or abundance of organisms (insects, PPNs, spores,)
- Location of inoculum
- Susceptibility of the host
- Favorable environmental conditions (temperatures (18-30°C), RH% (50-95%), wind direction and speed, soil moisture, host stage (susceptible) and plenty of food resource

Plant Diseases

The Disease Triangle

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Disease triangle

Pathogen

Does it need a wound to infect a host?

Can it survive in the environment without a host?

soil, water
on alternate host

How does it move around?

airborne/waterborne
animal vectors
humans

Virulence + reproductive potential = transmission

Host

Must be physically present with pathogen

Must be physically compatible with pathogen

Must provide window of opportunity for infection

Tolerance

losses where infected
but ability to redirect resources

What type of resistance?

simple= one gene

complex=several genes

Environment

Climatic changes

Climate patterns match pathogen biology
(high RH, rainfall when needed, temperature range for growth: thermophilic vs. psychrophilic organisms, Max-min temperatures)

Host phenology: synchrony between pathogen and Host (is it the host's most susceptible time period)

Examples of diseases transmitted (bacterial pathogens)

Bacterial wilt

- seed borne (survives for many years), survives on plant debris and susceptible weeds
- Spread by surface irrigation, hailstorms, can infect host through wounds, through movement of infested soils

Other bacteria can be carried on insect legs and mouth parts, implements, mans movement passively

Common blight of beans

- Seed borne, spread via natural openings and wounds, wind driven rain, hailstorms, insects and farm implements

Halo blight

- Seed borne, spread by splattering rain water, hailstorms, wind blown rain

Examples of diseases spread (fungal pathogens)

- Fungi (Alternaria leaf spot):
 - Spores disseminated by wind, rain, insects, and fungus is also found in seed
- Fungi (Fusarium root rot):
 - Spread by drainage water or irrigation water, movement of infected soil, man, farm implements, soil in touch with seed
- White mould:
 - Spread by sclerotia on seed, air borne ascospores,
- Fungi (Rhizoctonia):
 - Soil borne fungus spread by soil movement from one place to another (shoes, potting soils)

Examples of diseases (nematodes and viruses)

Plant parasitic nematodes

- through infested soils, eggs on seeds or plant parts, vegetative planting materials, insects e.g **RKNs, Cyst nematode**

Common mosaic

- In weed hosts where inoculum is picked by insects (aphids) or mechanically spread by plants rubbing against one another or against weed hosts, through infected seed, can be spread in pollen

Golden mosaic of beans

- Not seed transmitted, but is mechanically transmitted, and by whitefly vectors

Plant pathogens spread by vectors

- This involves an interaction of
 - Plant (susceptible host)
 - Pathogen (inoculum – spores) ,
 - insect vector,
 - Environment (weather, cultural practices in the field, farming operations, agroecosystem)

(Remember disease triangle)

Contributing factors to the spread of diseases

- Environmental changes (Narok vs Naivasha MLND expts)
- Microbial adaptation
- Human populations and behaviour
- Technology and economic development
- International travel and commerce

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Ways of disease spread by vectors

- Passive or mechanical : occurs when the insect/vector carries /transfer the pathogen from one plant to another. In this method the pathogen is kind of given a ride, there is no effect on the vector (legs, mouthparts, bodies)
- Active or biological transmission : in this, the pathogen undergoes some change within the vector. It may multiply or develop into infectious form after which it is transmitted to a new host

Contd ways of spreading disease by vectors

- Inoculation: the pathogen is injected onto the host in saliva while the vector is feeding,
- Regurgitation: the pathogen multiplies within the vectors gut to a point where it interferes with feeding and hence it is vomited into the new host,
- Faecal contamination: the insect deposits faecal matter with the pathogen on a wound on the host or the pathogen may infect a new wound created while the insect is ovipositing

Categories of insect vectored pathogens

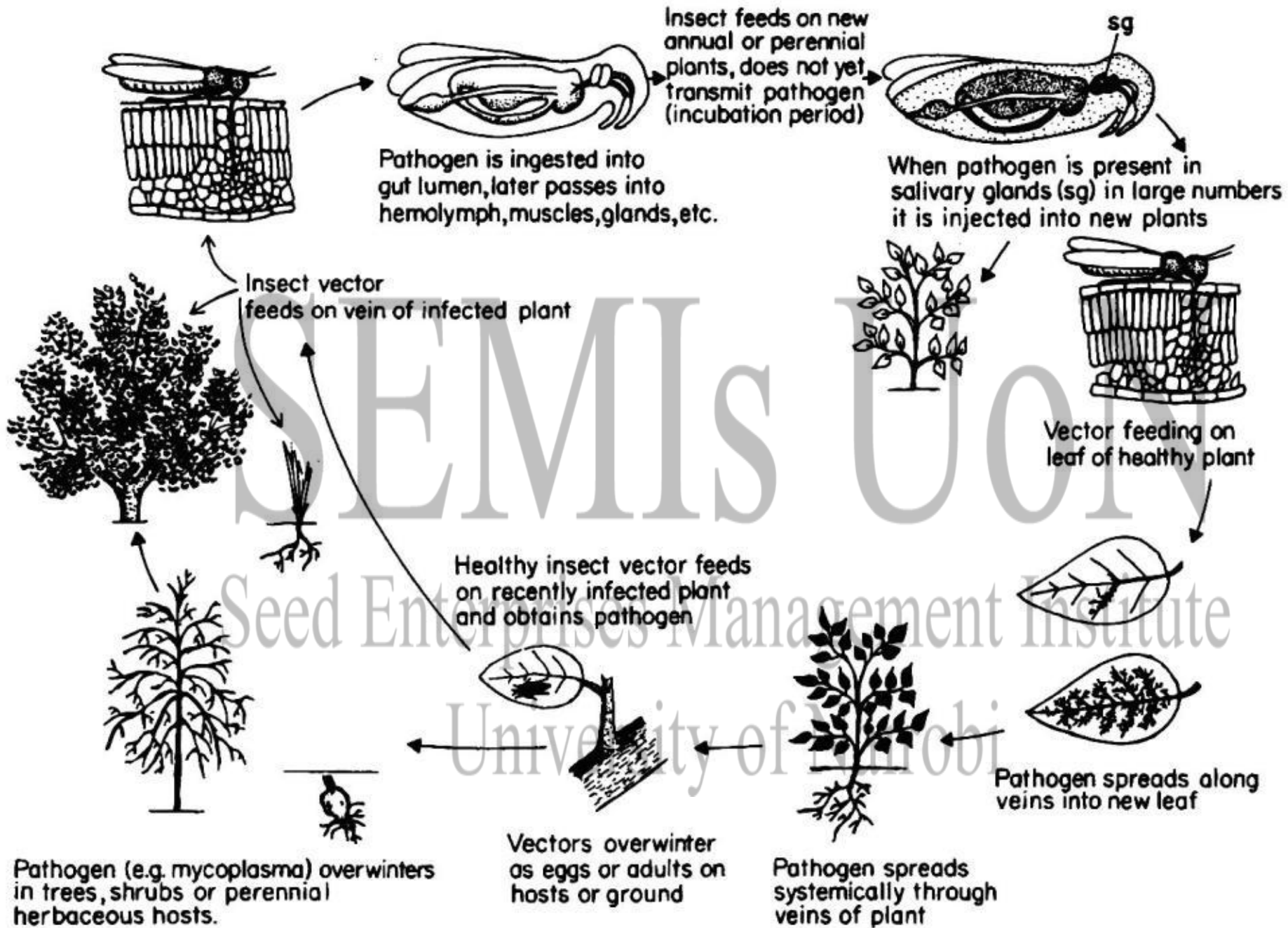
- Pathogen spread
 - Primary (brought into field first round) vs Secondary (spreads within field after the first inoculation)

Modes of primary infections:

Primary infection plant diseases are recognized as:-

- Soil borne (bacterial pathogens)
- Seed borne, including diseases carried with planting material e.g smuts on cereals especially maize, wheat, bacteria in tubers, viruses in seed, tubers.
- Wind borne
- Insect borne

Is also direct transmission which can be internal or external



Secondary infections

- Pathogen spreads itself by way of its persistent growth or certain structures carried independently by natural agencies like wind, water, animals, insects, mites, nematodes, birds
- Pathogen spreads within the field

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Categories of insect vectored pathogens

- Vector residency on plant
 - Transient (passing by) vs residential (settles down feeds and reproduces)
- Vector dispersal
 - Trivial (not organized and vector moves randomly searching for hosts to feed) vs migration (vector purposes to move into a new area to search for food or reproduce)

Examples of insect vectors that spread disease

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True bug, leaf hopper,
plant hopper



Aphids, mealy bug,
psyllid, whiteflies,

Homoptera pests

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Insects pests of different orders



Fruit fly (*R. pomonella*)



Thrips (*F. williamsi*)



Cabbage fly- maggot



leafminer



Leaf beetles



Bark beetles

Insects pests of different orders



Plum beetle

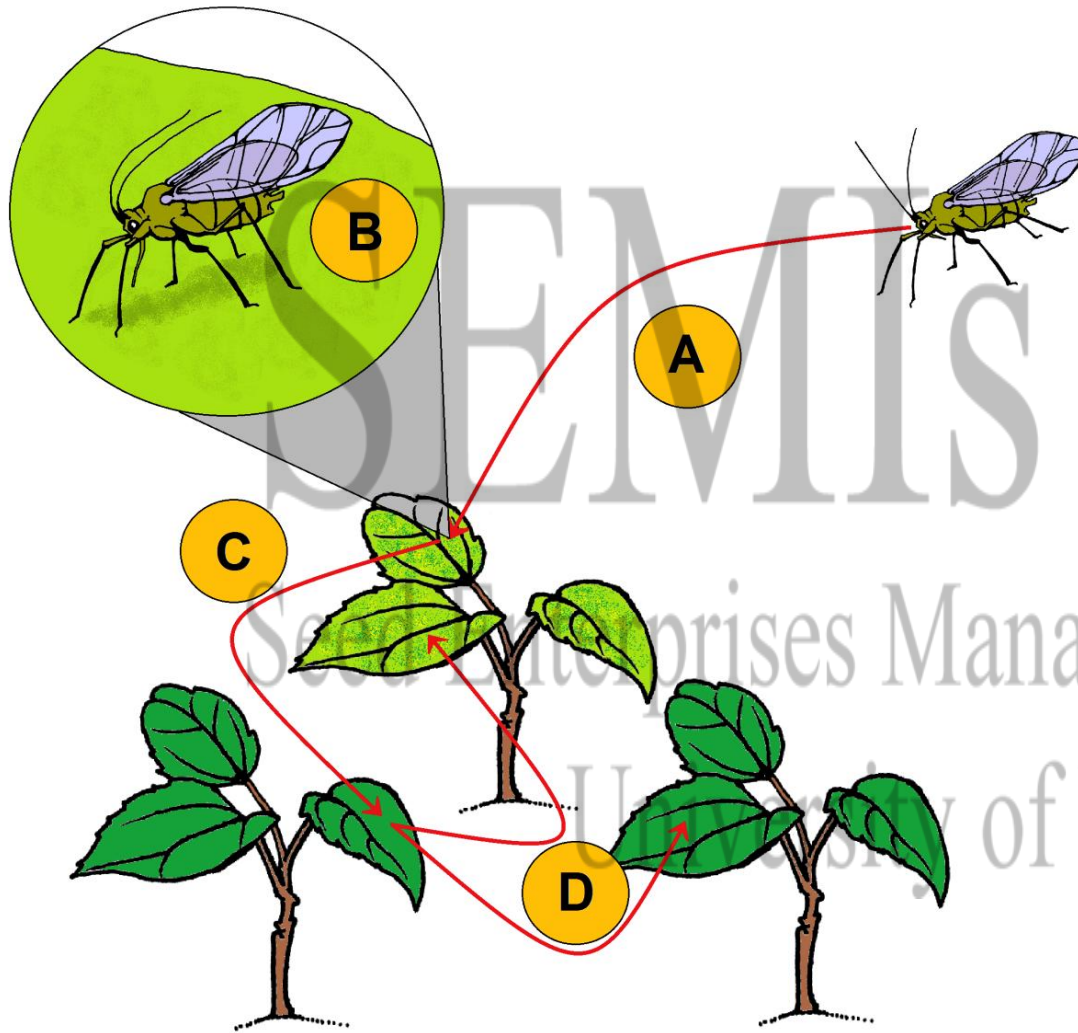


Bee *Apis mellifera*



Ants

Plant Virus Infection and Vector Behavior



Types of interactions

- Circulative (2 forms)
 - Systemic :movement within body
 - Propagative :Replication within body – transovarior
- Non circulative (stylet borne)
 - No replication particles attached to mouth parts during feeding and pathogen released during feeding through saliva

Types of pathogen transmission

- Non persistent (Stylet borne)
- Persistent (circulative, propagative and transovarior)
- Semi persistent (partly circulative)

Non persistent vs persistent

Non persistent

- Acquisition time - short (seconds)
- Inoculation time –short
- Latent period –zero
- Retention time – minutes to hours

Persistent

- Acquisition time - minutes
- Inoculation time –minutes
- Latent period – one or more days
- Retention time – through moult or for life
- Vector specificity high

Categories of vectors

- **Transient vectors**

- Do not colonize host
- Non persistent spread of diseases
- Not usually important for persistent disease spread

- **Resident vectors**

- Colonize crop
- Important for all types of disease spread
- Most important for persistent transmission of diseases

To determine transient populations: use traps such as sticky traps, water pans, pheromone traps, etc

Vector dispersal

- **Trivial flights**

- Random movement among selected hosts
- Important for secondary spread
- Important for non persistent spread of disease

- **Insect migration**

- Long distant obligatory flights
 - Important for all transmissions
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- Primary spread acquired from outside source and brought in to the field e.g through seed or immigrating insects such as thrips
 - Secondary spread infections within the field

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