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Mechanism of Seed Transmission

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Spread or transfer of pathogen, which occurs by the means of seed and planting material, is referred to as seed transmission. Mechanism by which the seed caries the pathogen is very important in order to formulate the management strategy. It is essential to devise the control measures for the seed borne pathogens.

Introduction

Use of clean seed is an important disease control measure because seed transmits plant pathogens and seed is exchanged worldwide. Each year, seeds are exchanged throughout the world by commercial seed trading activities through germ plasm exchange activities of international organizations, public and private institutions. Seed has continues to be an important vehicle for transmitting plant pathogens worldwide. Seed-borne fungi, bacteria and viruses result in yield losses, reduction in seed germination, increased risk of deterioration in storage, and harmful effects on humans and animals because of toxic metabolites of certain mold fungi.

Spread or transfer of pathogen, which occurs by the means of seed and planting material, is referred to as seed transmission. Mechanism by which the seed carries the pathogen is very important in order to formulate the management strategy. The seed borne pathogens may result in (i) loss in germination (ii) discolouration and shrivelling (iii) development of plant diseases (iv) distribution of pathogen to new areas (v) introduction of new strains or physiologic races of the pathogen along with new germplasm from other countries (vi) toxin production in infected seed etc.

Importance

- Seed transmission reflects the inoculum load on the seed
- It is essential to devise the control measures for the seed borne pathogens.

Types of seed Transmission

- Transmission of biotrophs causing systemic infection.
- Transmission of nectrotrophs causing local and vascular infection.
- Transmission by organisms accompanying seeds.

A. Transmission of Biotrophs Causing Systemic Infection

By contaminated seeds: Pathogen causes infection at seedling stage and move systemically in the host plants. This can be effectively controlled by seed treatment. E.g. Teliospores are the contaminating agents of bunt & smut fungi.

By infected seed coat or pericarps: Surface borne biotrophic pathogens are located deeper in seed tissues from which the transmission occurs. E.g. Downy mildew of sunflower - *Plasmopara helianthi*

By infected embryonic axis*:* The mycelium of the fungus is located in the scutellum region of the seed. When seed germinates, the mycelium also gets activated and move to the crown node to enter the growing point of young tillers. E.g. Loose smut of wheat.

B. Transmission of Nectrotrophs Causing Local and Vascular Infection

- **Seed transmission causing local infection**
  - Contaminated seeds: Contamination occurs during threshing & cleaning of seeds. E.g. *Alternaria sp, Phoma sp, Pseudomonas syringae pv pisi.*
  - Infected seeds: Transmission from seed coat & pericarp tissues of seeds cause progressive invasion to seedling causing seedling blight, leaf spots, root rots. **E.g.** *Alternaria sp, Botrytis sp, Pseudomonas sp, Colletotrichum sp, Ascochyta sp, Septoria sp*
- **Seed transmission causing vascular infections**

  Wilt causing pathogens cause vascular infections**.** E.g. *Fusarium sp, Verticillium sp.*

C. Transmission by Organisms Accompanying Seeds

Fungal resting bodies and spores: Resting bodies like sclerotia are transmitted through admixtures. E.g. *Sclerotinia sp, Claviceps sp.*

Organisms on or in plant debris: Diseased pieces of plant debris act as a means of introduction of pathogen through seeds. E.g. *Septoria sp, Clavibacter sp, Pseudomonas sp, Plasmodiophora sp.*

Superficial inoculums on seeds: In covered smut of barley & flag smut of wheat it is estimated that 16000 spores/seed can produce maximum number of infected ears. In case of hill bunt 3600-15000 spores/seed and for *Fusarium* sp 5-50 million spores/seed are produced. Disease establishment can be achieved by 100-500 spores/seed for various pathogens.

Internal inoculums in seeds: Internal inoculum in seeds is more potent than externally present. Eg. *A. brassicola, C. lindemuthianum.*

Environmental Factors Affecting Transmission

Temperature and moisture affects on seed borne biotrophs: Teliospores of hill bunt & flag smut of wheat germinate in soil at 10-15°C at 11% moisture but Spore germination is reduced by high temperature (20-25°C) & dry soil conditions.

Temperature and moisture affects seed borne nectrotrophs: *Fusarium* foot rot & seedling blight are high in dry soil. *Macrophomina phaseolina* infected seeds of sunflower had no losses at 25°C but 74% loss was observed at 35°C.

Temperature and moisture affects on seed borne vascular pathogen: *Verticillium* wilt occurs at moist soil with temperature 21°C & neutral. *Fusarium* wilt occurs at warm dry soil with 28°C under conditions of low light intensity & acidic pH.

Soil microflora effects on seed transmission of diseases: Seed transmission rate is reduced in unsterilized soils due to chaemotaxis and antagonism. *Fusarium* sp. has been contained to great extent by suppressive soils.

Entry Points of Seed Infection

The maturing seed may be infected by two ways

1. **Direction infection from mother plant:** It occurs through transmission of inoculum from mother plant to seeds.
2. **Indirect infection from outside source:** Transmission of inoculums from outside to the flowers, fruits or seed by wind rain drops, insect.

Direct infection from mother plant: Direct infection occurs through previously infected mother plant act as source for inoculums for further infection of seed. Infection directly from mother plant mainly through the flower or fruit stalk (pedicle, peduncle) and the seed stalk, (funiculus), directly from seed surface. Mostly embryo infecting virus as well as some vascular infecting virus invade the ovule or young seed through funiculus. For example, *Xanthomonas phaseoli* causing common bacterial blight of bean penetrates the ovule through the vascular system of the pedicel and pass into raphe leading to seed coat they are also entering to micropyle. *Fusarium oxysporum* in cotton also entering in to seed funiculus consist vascular tissue but infected plant do not shows any symptoms. Only brown decay of maturing seed is indicating infection. Some nematode like *Ditylenchus dipsaci* also migrating through pedicel and placenta in to ovary from mother plant.

Indirect infection from outside: Inoculum may be transmitted from outside to the flowers, fruit or seeds and to the maturing fruit or seeds. Dissemination may occur by wind, raindrops, insect less frequently during the harvest and processing of the seed crop.

Stigma as Path of Infection

Stigma of flower receives the inoculums through wind the spore starts germination and developing through style. So stigma acts as path for infection of seed. There are two types blossom infection through stigma. They are:

Intra embryal infection through stigma: Here infection mainly occurs through pollen there are also possibility of the embryo infection. Pollen also involved transmitting virus in several crop.

Example:

- Loose smut of barley and wheat caused by *Ustilago nuda* and *Ustilago tritici* are typical example for internally seed borne fungi which are also infecting embryo.
- *Xanthomonas stewartii* also being transmitted by pollen.
- *Chilli mosaic virus* transmission takes place through pollen. Generally there seems to be a parallelism between pollen transmission and seed transmission of viruses. *Bean yellow mosaic virus* is transmitted by pollen and seed. Several stone fruits viruses likewise pollen and seed transmitted.

Extra embryal infection through stigma: Here blossom may be infected but infection restricted to other parts i.e. embryo. Loose smut of oats of oats caused by *Ustilago avanae* is

classical the example. Barley leaf stripe disease is caused by *Dreschslera graminea.* Both are examples for blossom and seedlings infection. On both cases receptive stigma caught spores on sticky surface. The hyphae grow along with style but do not grow in to the epidermis and the caryopsis where they establish that dormant mycelium.

Nectar as Path of Infection

There is possibility of the nectar being an entrance for pathogens, Eg. *Erwinia amylovora*, fire blight of fruit trees. This pathogen infects ovaries and young twigs through the nectarines but is not known to be seed transmitted. In cotton entry of boll rot fungi in to boll mainly through inner and outer wall nectarines.

Ovary Wall, Pericarp and Integuments of Seed Coats as Path for Infection

The teliospore of smut fungi disseminated by wind to young florets. They lodge on the feathery stigma, the style and on the ovary wall and within one day spores germinates and produces promycelia. The infection occurs through any part of the epidermal cells often through center of the cell wall. At the entry point appresorium is formed the vigorous pointed hyphae enters within two days. Some of the hyphae penetrate epidermal and sub epidermal layer. Then the hyphae continue transversing the parenchyma of the pericarp and grow directly towards the integuments. Now the hyphae follow the collapsed integuments towards embryo after eleven days mycelia enters to nucleus region. Three to four weeks after germination of the teliospores the hyphae reach the embryo. On the upper side of the grain the fungus grows from testa, nucellus and aleuron to the scutellum and passes to the meristem of the embryo. During maturation of caryopsis the mycelia changed to thick walled, swollen, dormant mycelium. Eg. Loose smut of wheat. Also, the bean anthracnose fungus *Colletotrichum lindemuthianum* and the pea blight fungi *Ascochyta pisi* may penetrate pod at different stages during its development and directly invade the maturing seeds. Bean pathogenic bacteria *Xanthomonas phaseoli* also penetrate through tissues of pods towards seeds.

Flower and Fruit Stalk As Path of Infection

Some pathogens like *Colletotrichum* and *Aureobasidium lini* on flax are penetrate in to capsule from infected petals through point of attachment without producing visible symptoms. *Septoria lincola* also penetrates through fruitstalk into the capsule from the placenta through the funiculus in to the seed coat.

Conclusion

Thus seed play a major role in transmission of disease. The inoculums load and rate of transmission has a direct correlation with the spread of disease. The quarantine acts has been regulated in order to avoid the spread of disease from one place to another. Hence selection of disease free healthy seeds and the appropriate seed treatments with pesticides waves to disease free environment and also good yield.