

Role of Fungi in Seed Deterioration

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What is seed quality?

What do we want from our seeds?

- Uniform successful germination

What we do not want to see

Weedy crop

Uneven maturity

Diseased crop

What is seed quality?

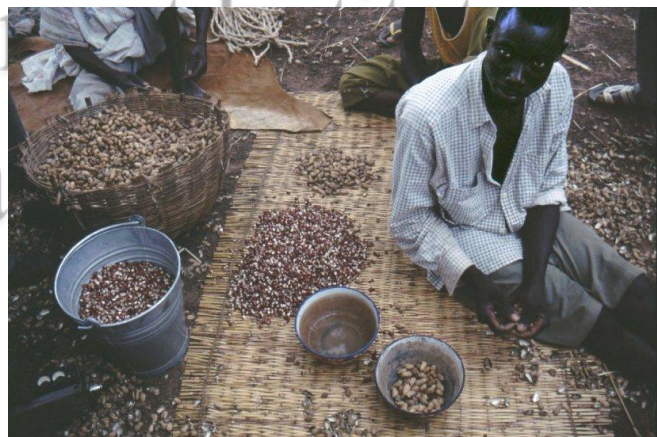
- Specific aspects – in forgoing sessions (details & how to measure)
- Here focus is on effect of Fungi





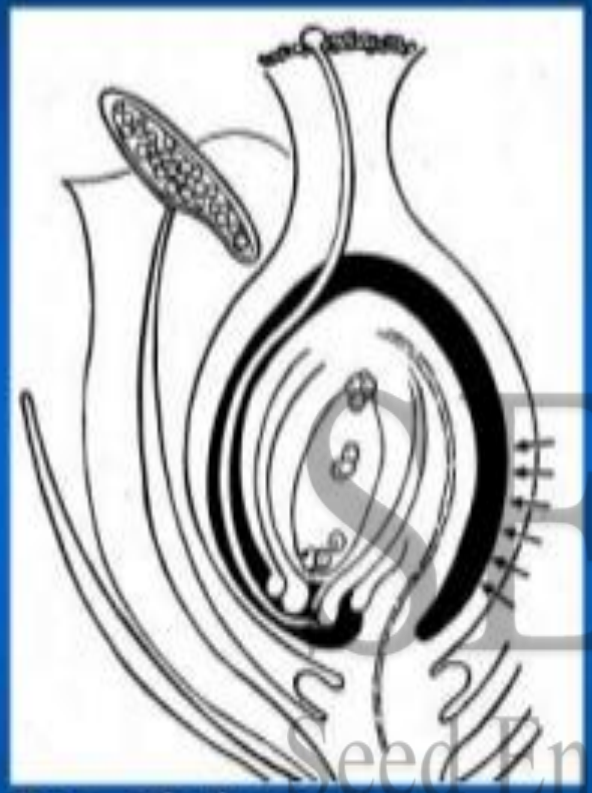
Paths of seed infection

- Active infection - Systemic infection
- Contamination in the field, during harvesting, threshing, processing and storage
  - The pathogen may then be carried with the seeds in these ways

Routes of active seed infection

A. Penetration through ovary wall



E.g.: *Cladosporium variabile* (spinach), *Botrytis* spp. (onion)

B. Systemic infection via vascular system

E.g.: Vascular wilt fungi, endophytes

C. Penetration through floral parts

E.g.: *Ustilago nuda* (grains) *Cucumber mosaic virus*

From Maude (1996)

Pollen tube entry into seed

Examples:

1. loose smut of small grains
2. CMV in spinach

Certification programs, host resistance, systemic fungicides

Indirect infection via flower or fruit

- Weak necrotrophs:
  - *Botrytis cinerea* - infected petals remain attached to developing fruit
- Aggressive necrotrophs:
  - Attack floral parts directly
  - e.g., *Ascochyta pisi*, *Alternaria brassicicola*

- Fleshy fruits (e.g., Solanaceae) – seed attached to central placenta
  - infect via calyx – placenta – funicle – embryo
- Umbelliferae & Liliaceae – flowers exposed in umbels
- Seed transmission is typically discontinuous (infection outside embryo)
  - affected by intrinsic & environmental conditions



Impact of seed borne fungi on seeds and seedlings - 1

- Seeds carry a wide range of fungal contaminants
- Depending on
  - ✓effectiveness of storage conditions
  - ✓Climatic

  the (a) level and

  (b) type of contamination

  will vary

Impact of seed borne fungi on seeds and seedlings - 2

- Based on in vitro seed inoculation tests, categories of fungi observed are those that are:
    1. pathogenic only to seeds and have no obvious impacts on the germlings
    2. pathogenic only to the germlings
    3. pathogenic both to seeds and the emerging germlings
    4. production of harmful mycotoxins
    5. more or less harmless and
    6. germination promoters

Seed deterioration due to fungal invasion - 1

- Seed discoloration
  - ✓Is not the only symptom of infection
- Reduction in germination and vigor index
- Some produce metabolites which have biochemical effects on seeds:
  - ✓Reduction in seed content (decreased percentage of protein, carbohydrates, fat, fiber, ash content) and seed health.
  - ✓Fungi use seed content for growth



Seed deterioration due to fungal invasion - 2

- Fungi produce humidity and raise temp during growth
  - ✓Heating and mustiness
- Chemical and nutritional changes due to enzymatic activities
- Complete loss of seed

Some fungal metabolites - 1

Mycotoxin	Organism
Acetoxyscirpenediol	*Fusarium moniliforme, F. equiseti, F. oxysporum, F. culmorum, F. avenaceum, F. roseum, and F. nivale*
Acetyldeoxynivalenol	*Acetyldeoxynivalenol Fusarium moniliforme, F. equiseti, F. oxysporum, F. culmorum, F. avenaceum, F. roseum, and F. nivale*
Acetylneosolaniol	*Fusarium moniliforme, F. equiseti, F. oxysporum, F. culmorum, F. avenaceum, F. roseum, and F. nivale*
Acetyl T-2 toxin	*Fusarium moniliforme, F. equiseti, F. oxysporum, F. culmorum, F. avenaceum, F. roseum, and F. nivale*
Aflatoxin	*Aspergillus flavus, A. parasiticus*
Aflatrem	*Aspergillus flavus*
Altenuic acid	*Alternaria alternata*
Alternariol	*Alternaria alternata*
Austdiol	*Aspergillus ustus*
Austamide	*Aspergillus ustus*



Some fungal metabolites - 2

Mycotoxin	Organism
Oxalic acid	*Aspergillus niger*
Patulin	*Aspergillus clavatus*, *Penicillium expansum*, *Botrytis*, *P.roquefortii*, *P. claviforme*, *P. griseofulvum*
Penicillic acid	*Aspergillus ochraceus*
Penitrem	*Penicillium crustosum*
Fusaric acid	*Fusarium moniliforme*
Fusarin	*Fusarium moniliforme*
Neosolaniol	*Fusarium moniliforme, F. solani, F. culmorum, F.avenaceum, and F. roseum*
Nivalenol	*Fusarium moniliforme, F. equiseti, F. oxysporum, F.culmorum, F. avenaceum, F. roseum, and F. nivale*
NT-2 toxin	*Fusarium moniliforme, F. equiseti, F. oxysporum, F.culmorum, F. solani, F. avenaceum, F. roseum, and F.nivale*
Ochratoxin	*Aspergillus ochraceus, Penicillium viridictum*

Management of fungal invasion in seeds - 1

- Seed selection protocol
- Thereafter to minimize the risk of fungi invasion, seeds have to be stored at low
  - ✓Moisture content
  - ✓Temperature and
  - ✓Relative humidity
- Use of fungicides
- Aeration



Management of fungal invasion in seeds - 2

- Moisture content is the most important factor affecting fungal growth and metabolite production in stored products
- Grain itself and the microbial contaminants respire slowly when stored dry
- However, if the water availability is increased to 15 –19% moisture content, spoilage fungi, particularly *Eurotium* spp., *Aspergillus*, and *Penicillium* sp. grow resulting in increase in
  - ✓ Respiratory activity
  - ✓ Temperature
  - ✓ Metabolite production
  - ✓ Colonization by thermophilic fungi and actinomycetes

Management of fungal invasion in seeds - 3

- Relative humidity
  - ✓ Researches show that all storage fungi are completely inactive below 62% relative humidity and show very little activity,
  - ✓ About 75% relative humidity upwards, the amount of fungi in a seed often shows an exponential relationship with relative humidity
  - ✓ Storage bacteria require at least 90% relative humidity for growth and therefore only become significant under conditions in which fungi are already very active
    - ✓ E.g. Peanuts are stable at 70% relative humidity between 7 - 9% moisture content, at which conditions fungal growth is arrested