Importance - Economic Significance of Seed-borne Diseases - seed-borne pathogens

Importance of Seed-Borne Diseases

Importance of seed-borne disease can be seen or observed by the types of losses it causes. The impact of fungi on seed is considerable. The following are the impact of seed-borne diseases:

1- **Reduction in Crop Yield**

There are both qualitative as well as quantitative losses due to seed-borne diseases. The reduction in crop yields may occur due to many types of abnormalities.

(a) **Seed abortion:** It is seen mostly in smut and ergot fungi where flower organs of the hosts are replaced by the fructifications of the parasites, e.g. *Ustilago* sp. and *Claviceps* sp.

(b) **Shrunken seeds, reduced seed size:** It is seen in crucifers infected by *Alternaria brassicicola* and *Phoma lingam.*

(c) **Seed rot:** Many seed-borne fungi cause rots either in crop or during germination; e.g. *Fusarium avenaceum* and *Drechslera* sp. in cereals cause seed rot.

(d) **Sclerotization/stomatization of seed:** Transformation of floral organs or seed into sclerotia or stromata is an important disease condition in certain categories of fungi and host, e.g. ergot produced by *Claviceps purpurea*.

(e) **Seed necrosis:** Many seed-rotting fungi produce superficial necroses in the seed. Most seed-borne fungi usually do not go beyond the protective layer of the seed coat or pericarp. In leguminous seeds, anthracnose fungi *Colletotrichum* sp. as well as *Ascochyta* sp. often penetrate into the fleshy

cotyledons producing conspicuous necrotic lesions in seeds of bean, soybean, pea, chickpea, cowpea, etc.

(f) **Seed discolouration:** It is a very important degrading factor. It can be categorized broadly into three types, namely:

1. Superficial necrotic lesions: Many seed-borne parasitic fungi infect the seed coat causing conspicuous necrotic black-brown to grey discolouration, e.g. *Ascochyta pisi* in pea, *Colletotrichum lindemuthianum* in beans and *Drechslera oryzae* in rice (pecky rice).

2. Fungus coating: It is seen in black point/kernel smudge in cereals. Profuse growth is observed in *Drechslera sorokiniana* in wheat, *Drechslera oryzae* in paddy and *Drechslera teres* in barley.

3. Pigments: Different colours of pigments are observed in different pathogens, e.g. purple stain in soybean by *Cercospora kikuchii*, pink discolouration seeds of maize by *Fusarium moniliforme*, red discolouration in beans also called red nose by *Stemphylium botryosum,* pink stain in rice by *Trichoconiella padwickii* and blue stain in cotton lint by *Alternaria tenuis*.

(g) **Reduction or elimination of germination capacity/lowered viability:** It is seen in many wheat and barley diseases caused by smut fungi (Agarwal and Sinclair 1997).

2- Loss in Germination and Vigour

Many seed-borne pathogens become active when seeds are sown, which may result in seed decay and/or pre- or post-emergence damping off. This in turn results in poor plant stand in the field. Some examples of diseases which lead to loss in germination and vigour are listed below.

1-Stack burn (*Alternaria padwickii*) causes decay of rice seeds, roots and coleoptiles, resulting in the death of young seedlings.

2. *Fusarium moniliforme* (foot rot/bakanae) causes seed rot, seedling blight and brown discolouration in the coleoptile and in primary and secondary leaves of rice.

3. *Bipolaris oryzae* (brown spot)-infected rice seeds have been found to be lower in germination than healthy seeds.

4. *Neovossia indica* (karnal bunt)-infected wheat seeds have a significantly lower survival rate than healthy seeds.

5. *Colletotrichum truncatum* (anthracnose), *Drechslera phaseolorum* var. *sojae* (stem canker) and *Sclerotinia sclerotiorum* (sclerotinia stem rot) which are all internally seed-borne diseases of soybean show poor field emergence.

6. *Cercospora kikuchii* causing purple stain in soybean showed 12% reduction in seedling emergence and *Macrophomina phaseolina* causing charcoal rot showed decrease in seedling emergence by 59%.

7. *Phytophthora nicotianae* var. *parasitica* which causes fruit rot in tomato also resulted in poor germination. It was observed that seeds either failed to germinate, or if they germinated, seedlings were killed by the fungus. Similar observations were seen in barley seeds severely infected with spot blotch caused by *Bipolaris sorokiniana* which did not germinate, or if they germinated, seedlings became infected.

8. *Diplodia maydis* which causes stalk rot/white ear rot/root rot in maize also caused reduction in maize seed germination.

3- Development of Plant Diseases

A pathogen can be distributed to new areas through seeds. Plant pathogens have spread with planting material since crop cultivation began. Today, with expanded and rapid modes of transport, chances of spread through seeds have increased to include large areas within a country and from one country to another. The exchange of plant material between countries has enhanced the risks of introducing new pathogens with seeds. Thus, new strains or physiologic races of a pathogen may be introduced with new germ plasm from other countries.

Seeds are the most important means for perpetuation of plant pathogens. For certain pathogens, such as those that cause loose smut of wheat, covered smut of barley and barley stripe mosaic disease in barley and wheat, seeds are the exclusive means of survival. The role of such inocula in disease establishment in the field is well documented. Transmission of a pathogen through seeds is considered more important than other survival means. The pathogens remain viable longer in seeds than in vegetative plant parts or in soil. The host-parasite relationship within seeds also favours the earliest possible infection in the field. Since pathogens are in direct contact with the seeds, the chances of seedling infection are enhanced. Thus, seed-borne infection can provide a focus for inoculum, which may spread under favourable conditions and cause an epidemic.

A plant disease can develop into an epiphytotic condition, if the infected seeds are present in the seed lot used for sowing in large areas. For example, black rot of cabbage caused by *Xanthomonas campestris* pv. *campestris* even if the infection is 0.02%, it can result in epiphytotic condition. Similarly, in other bacterial pathogens like *Xanthomonas campestris* pv. *phaseoli* in bean infection of 0.5% and *Xanthomonas campestris* pv. *vesicatoria* if the infection is even less than 1%, it can result into an epiphytotic condition. Teliospores of *Tilletia controversa*, *T. laevis* and

T. caries can be disseminated widely by importation through the use of contaminated seeds, animal-derived fertilizers and natural movement of seed-eating migratory animals.

4- Discolouration and Shriveling

Discolouration can indicate undesirable physical qualities, the presence of toxic metabolites or other unfavourable seed characteristics. Discolouration on soybean seeds, caused by various microorganisms, which have long been used for diagnostic purposes, can indicate seed quality.

1. Soybean seeds infected with *Phomopsis longicolla* are elongated, smaller than normal, deeply fissured and covered with whitish mycelium.
2. Dull-grey to deep-brown patches and scattered, dark sunken areas on a soybean seed are due to infection by *Alternaria alternata* and *A. tenuissima.*
3. Salmon or pink to red discolouration anywhere on a soybean seed coat may be associated with infection by *Fusarium graminearum* and *F. sporotrichioides*.
4. Irregular brown or grey areas with black specks develop on soybean seed coats infected with *Colletotrichum truncatum.*
5. Purple stain caused by *Cercospora kikuchii* can vary from violet to pale purple to dark purple, and the colour tends to bleed from the hilum.
6. Seeds from a soybean plant with downy mildew become encrusted with oospores of *Peronospora manshurica*.
7. Seeds from soybean plants with soybean mosaic virus are mottled with brown or black, depending on hilum colour.

8. Soybean seeds infected with *Cercospora sojina* develop conspicuous light- to dark-grey or brown areas that vary from minute specks to large blotches covering the entire seed coat. Some lesions show alternating bands of light- and dark-brown colour. Occasionally, brown and grey lesions diffuse into each other. Normally the seed coat cracks.
9. Symptoms on soybean seeds infected by *Macrophomina phaseolina* appear as indefinite black spots or blemishes on the seed coat.
10. 1Soybean seeds colonized with *F. oxysporum* appear shrunken, slightly irregular in shape, often with cracks in the seed coat with light- to dark-pink discoloured areas over most of the seed surface.

5- Biochemical Changes in Seeds

Many seed-borne fungi induce qualitative changes in the physicochemical properties of seeds, such as colour, odour, oil content, iodine and saponification value, refractive index and protein content, thereby affecting their commercial value. Biochemical deterioration and change in the quality of seed nutrients due to different pathogens have been observed. These include change in protein, oil, and other contents. Soybean seeds infected by *Fusarium* or *Phomopsis* have lower-quality oil, higher amounts of free fatty acids, poor meal colour. The chemical changes resulting in increased unsaturated fatty acids are undesirable and can cause obesity and cardiovascular disorders in humans. The oil content in sunflower seeds is reduced due to infection of *M. phaseolina*. The oil colour from inoculated seeds changes from light yellow to yellowish brown, and the free fatty acid content increases.

6- Alteration in Physical Properties of Seeds

Physical properties such as density, shape, size, surface, volume and weight are economically important and are affected by many fungal species such as *Alternaria,*

Fusarium and *Phomopsis* in soybean. *Phomopsis* reduced seed density by 4% and volume and weight by 13%, with a resultant potential of seed breakage 20 times greater than that for asymptomatic seeds.

Economic Losses and Impact on Society

Crop losses due to seed-borne diseases are commonly displayed in the form of disastrous effects of plant disease epidemics. Whether long or short, localized or widespread, weak or massive spread of diseases, all poses a quite different outcomes with different dimensions. For example, various seed-borne diseases cause wide range of yield losses in rice crop.

With the advancement of new plant disease management practices, like availability of seeds of new variety which are host resistant and tolerant, more effective seed treating fungicides and biocontrol agents and integrated pest management, all these have reduced the frequency of disease epidemics in recent years.

Seed-borne pathogens

Seeds are regarded as a highly effective means for transporting plant pathogens over long distances. Seed borne microorganisms include fungi, bacteria, viruses, and nematodes. Fungi have a wide range of mechanisms for becoming seed-borne and for being transmitted for germinating seedlings.