Stem (Black) Rust of Wheat:

Description:

- Major disease of wheat (quantitative and qualitative losses) that occurs worldwide. Most common where dews are frequent during & after heading (flowering).
- Appears in March

History and Importance:

Wheat stem rust was a serious problem in ancient Greece and Rome. The ancient Romans sacrificed red animals such as dogs, foxes, and cows to the rust god, Robigo or Robigus, each spring during the festival called the Robigalia in hopes that the wheat crop would be spared from the ravages of the rust. This festival was incorporated into the early Christian calendar as St. Mark's Day or Rogation on April 25.

Potential threat to world food supply as it causes 50-70% yield losses. More than $2 billion are lost due to stem rust worldwide.

Etiology:

Causal organism: *Puccinia graminis* f.sp. *tritici*

Order: Uredinales

Family: Puccinaceae

Symptoms:

- Dark brown pustules appeared on stalk, leaf sheath & some times on leaves
- Brown powdery mass of uredospores is exposed for dispersal
- Later telia*(sac like structure which contains teliospores) develop & pustules changed from to black
- In severe attack plants look sickly & fail to emerge normal ears
- Grains shriveled & lighter in weight

Disease cycle: (Stem rust is a macrocylic fungus*(produces five type of spores. i.e. Aeciospores, Uredospores, Teliospores, Basidiospores, Pycniospores)

- Aeciospores from alternate host (Barberry, Mahonia) are primary source of inoculum
- Mycelium & uredinia on volunteer plants are also the source of infection
- Uredia are wind blown

- Aeciospores from alternate host land on wheat
- On wheat aeciospores germinate & produce urediospores
- In the season disease spread through uredia to uredia cycle
- As crop near to mature telia developed which later produce basidiospores
- Basidiospores produced on wheat but attack on barberry (alternate host)
- Basidiospores germinate to produce spermatia & receptive hyphae (pycnospores)
- Pycnospores fuses to produce aeciospores

Epidemiology:

- Free water on plants & temp 18-29.5°C

Management:

- ✓ Removal of alternate hosts and weeds.
- ✓ Early sowing (Crop will mature early and may escape the incidence of stem rust).
- ✓ Fungicides: Azoxystrobin at 200 g/liter + cyproconazole at 80 g/liter, tebuconazole + tridimenol.
- ✓ Sow resistant varieties i.e. Anaj 2017 and Akbar 2019.

Leaf (Brown) Rust of Wheat:

Description:

- Most prevalent*(found frequent occurrence) where dews are common
- Disease severity increases prior to heading
- Early infection results in weak plants, poor roots & tiller formation.
- Appears in February after yellow rust.
- Leaf rust causes damage by reducing number of kernels per head and kernel size.

Importance:

- Cause losses up to 50% in severe cases.
- Estimated losses over $350 million in USA alone.

Etiology:

Causal organism: *Puccinia recondita* f.s.p. *tritici*

Order: Uredinales

Family: Puccinaceae

Symptoms:

- Pustules have uredia that develop as points of bright orange color on leaves.
- Spots are rare on sheath & stalk.
- These pustules are bigger in size than of yellow rust, scattered irregularly.
- Infected plants take longer time to produce mature ears*(grain bearing part).
- Rust pustules can be distinguished from other leaf spot diseases by rubbing finger on leaf surface.

Disease cycle:

- Uredia*(sac like structure that bears urediniospores) over seasons on volunteer plants.
- Alternate host *Thallactrum flavum* (bushy plant) also harbors fungal spores.
- Aeciospores from alternate host dispersed by wind.

Epidemiology:

- Free water on leaf & 18.3-23.9°C favors the spore germination.

Management:

- ✓ Destruction of alternate host.
- ✓ Use fungicides i.e. carbendazim, propiconazole, difenoconazole.
- ✓ Sow resistant varieties i.e. Anaj 2017 and Akbar 2019.

Stripe (Yellow) Rust of Wheat:

Description and Importance:

- Generally, occur throughout wheat production areas at low temperature
- Losses due to this are 50-55% with some field destroyed completely

Etiology:

Causal organism: *Puccinia striformis* f.sp. *tritici*

Order: Uredinales

Family: Puccinaceae

Symptoms:

- Small yellowish uredia appear in narrow linear rows on the leaf.

- Uredia can also be seen on spikes.
- Yellow spore mass is exposed for wind dispersal.
- Plants show poorly developed root system

Disease cycle:

- Uredospores are single source of inoculum
- Inoculum comes from volunteer plants
- Fungus survive between crop seasons by dormant mycelium & uredia
- Windblown uredospores are secondary source

Epidemiology:

- Free water on leaves & temp 0-25°C required for spore germination
- Appear in Dec, Jan, opt temp 12.8-18.3°C

Management:

- Resistant varieties (Anaj 2017, Akbar 2019)
- Cultivation of early sowing and early maturing varieties.
- Avoiding thick sowing and heavy irrigation.
- Avoiding heavy doses of nitrogenous fertilizers.
- Judicious use of potassic fertilizer help in minimizing the susceptibility of plants
- Use fungicides i.e. Nativo, Bayleton, Tilt

Brown Leaf Spot of Rice:

Description:

Common*(present in all rice growing areas) disease of rice, caused by a fungus that infects coleoptiles*(protective sheath that cover leaf), leaves, panicle, glumes (outer husk surrounding the grain). It can occur at all stages but more severe from tillering to maturity stages.

History and Importance:

It causes high yield losses (up to 90%). It appeared in epidemic form in India and caused complete crop failure that was regarded Great Bengal Famine 1943.

Etiology:

Causal organism: *Bipolaris oryzae*

Symptoms:

- In early stage small dark brown spots*(necrotic area with defined margin) on leaves, coleoptiles etc.
- With the passage of time oval shaped brown lesions (wound) with grayish centers are found on leaves, coleoptiles.
- Dark brown to black spots on glumes and panicles.
- Infected grains become discolored and are known as “Pecky Rice”

Disease cycle:

- Fungus can survive in seed up to 4 years. Sowing of infected seeds give rise to infected seedlings from where fungal spores spread through air or wind and infect other plants.
- Other sources for survival of fungal spores are weeds and plant debris.

Epidemiology:

Pathogen is the most active at high relative humidity (86-100%) and temperature (16-36°C). Leaf wetness between 8-24 hours favors the disease. Poorly drained and nutrient deficient soils are the hot spot for pathogen multiplication.

Management:

- ✓ Pre-sowing hot water treatment of seed at 53-54°C for 10-12 minutes.
- ✓ Seed treatment with fungicides i.e. Captan, Thiram, Mancozeb.
- ✓ At tillering and booting stage spray with Mancozeb and Tricyclazole.
- ✓ Apply calcium silicate before sowing.

Rice Blast:

Description:

It is found wherever rice is grown and it has become potential threat to food security due to pathogen's ability to survive in harsh environments and easy spread.

Importance:

Each year it is estimated to destroy enough rice to feed more than 60 million people. The fungus is known to occur in 85 countries worldwide.

Etiology:

Causal organism: *Pyricularia oryzae*

Order: Moniliales

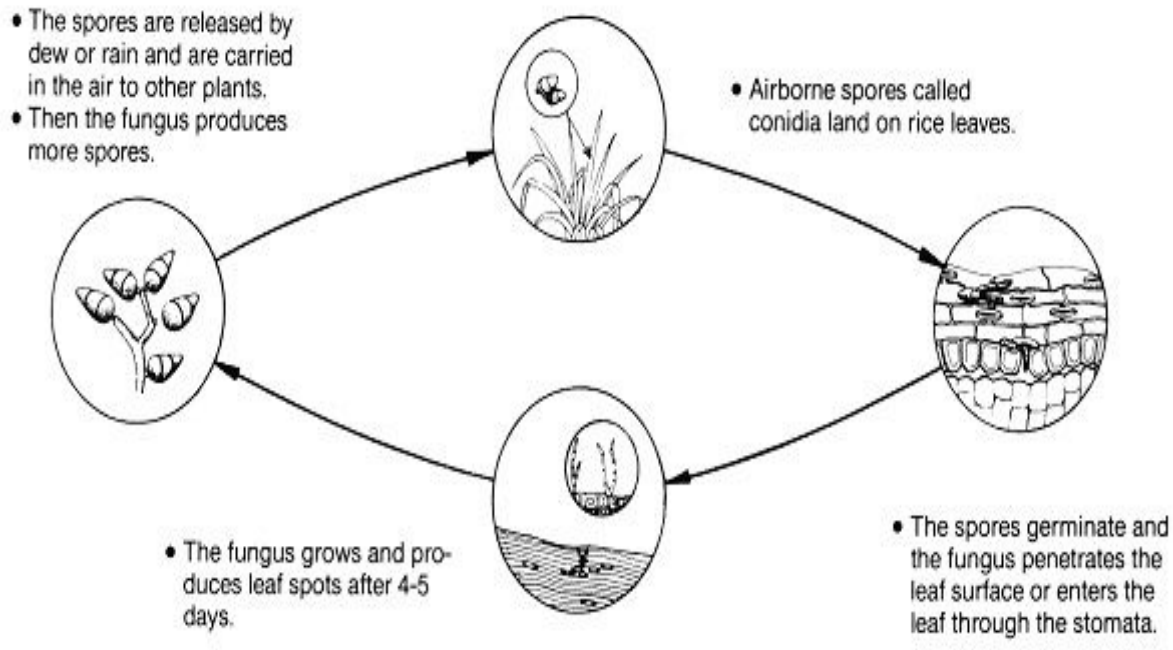
Family: Dematiaceae

Symptoms:

The fungus attacks all aboveground parts of the rice plant. Depending on the site of symptom rice blast is referred as leaf blast, collar blast, node blast and neck blast.

- Leaf blast: The lesions on leaf blade are elliptical*(resemble with oval) or spindle*(tooth pick shaped) shaped with brown borders and gray centers.
- Collar blast: It occurs when the pathogen infects the collar*(collar like band present at the base where leaf is connected to stem) that can kill the entire leaf blade*(broad portion of leaf).
- Node blast: The pathogen also infects the node of the stem that turns blackish and breaks easily.
- Neck blast: The panicle can also be infected. Infected neck is girdled by a grayish brown lesion that makes panicle fall over when infection is severe.

Disease cycle:



Epidemiology:

- Cloudy skies, frequent rain, and drizzles favor the development and severity of rice blast.
- High nitrogen levels, high relative humidity, and wet leaves encourage infection caused by the fungus.
- The rate of sporulation*(fungus spore production) is highest with increasing relative humidity of 90% or higher.
- For leaf wetness, the optimum temperature for germination of the pathogen is 25-28 °C.

Management:

- ✓ Cultural practices: Field sanitation*(to remove weeds, debris which may harbor the pathogen), destruction of alternate host*(which can be infected apart from rice).
- ✓ Nitrogenous fertilizer should be applied in minimum doses to avoid from prolonged vegetative period that is more likely to be attacked by the blast disease.
- ✓ Seed treatment with proper seed dressing fungicides such as Benlate (0.25%).
- ✓ Foliar sprays with Kasumin 2 WP, Benlate, Bavistin (0.1%).

Early Blight of Potato:

Occurrence & importance:

- Occurs in humid and warm areas of world
- Cause losses up to 5-78%
- $45 million is spent on fungicides to control early blight of potato.

Etiology:

Causal organism: *Alternaria solani*

Order: Moniliales

Family: Dematiaceae

Symptoms:

- On leaves dark brown spots appear surrounded by yellow halo.
- Concentric rings (like target board) develop. These spots resemble with bull's eye.
- In drought spots turn hard, in humid rotting patches appear
- Stem show brown to black lesions
- In severe attack leaves shriveled, dehisce*(split apart) & fall off.
- On infected tubers sunken*(deepen from normal surface) and irregular lesion appear.

Disease cycle:

- Fungi remain viable in dry infected leaves or debris for a year or more
- Contaminated tubers also primary source of inoculum
- Secondary infection occurs through wind, water & insects that aid fungal spores to move from infected to healthy plants.

Epidemiology:

- 13.6-23.6°C,
- Dew, Infrequent rain & more than 80 % RH favors the fungal growth.

Management:

- Cultural practices: a) crop rotation (b) Sanitation (c) burning of residues
- Spray Zineb, Dithane M-45 0.2%, Blitox-50 0.25% at 10-21 days interval.
- Resesitant genotypes i.e. Desiree

Late Blight of Potato:

History and Importance:

- ❖ Most destructive*(economic and social impact) disease of potato
- ❖ In 1845 destroyed large area in Europe (Ireland). Great Irish Famine
- ❖ Large No. of people died, remaining migrated

Etiology:

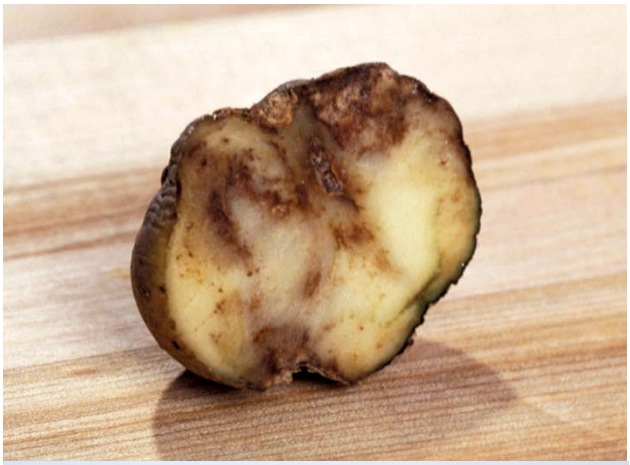
Causal organism: *Phytophthora infestans*

Order: Peronosporales

Family: Pythiaceae

Symptoms:

- On leaves and stem dark brown or black dead lesion*(injury/wound) appear
- Blighted areas appear as faded green patches
- In moist conditions decay giving offensive smell
- Dead areas started from tip or margins
- In severe attack tubers skin give black discoloration
- White sporulation appears on lower surface of leaves.
- Infected tuber tissues are copper brown, reddish or purplish in color.



Disease cycle:

- Pathogen survive from season to season in infected tubers in field or through contaminated seeds
- Secondary spread is through wind, water & leaf eating insects.
- Potato tubers can become infected in the field when sporangia are washed from lesions on the foliage and enter into the soil.
- Infections generally begin in tuber cracks, eyes or lenticels.

Epidemiology:

- 12-13°C temp.
- more than 90 % RH

Management:

- Seed tubers selected from healthy field
- Sanitation: weeding for low humidity
- Tuber treatment with mercuric chloride (1:1000)
- High ridging as 15 cm*(because low lying areas conserve more moisture that favors pathogen growth).
- Irrigation time should be adjusted in such a way that don't extend the night dew duration.
- Store in potato tubers in dry & well aerated place.
- Spray with systemic fungicides (dimethomorph, Cymoxanil, fluopicolide).
- Hilling: Covering of newly emerged plant at the base*(helps in early weed control and avoid from direct water contact).

Red Rot of Sugarcane:

Description:

- One of the oldest & widely distributed in Punjab & Sindh

History and Importance:

- First reported from Java in 1883
- In sub-continent in 1906

Etiology:

Causal organism: *Colletotrichum falcatum*
Order: Melanconiales
Family: Melanconiaceae

Symptoms:

- Yellowing and dropping of 3rd or 4th leaf from the top
- Midrib of leaves is also affected producing red patches with ash colored center having abundant fungal growth.
- Infected canes are lighter in weight and are easily broken.
- If split open longitudinally especially when withering of leaves starts, pith is found reddened.

Disease cycle:

- Fungus survive in soil & on planting material
- Ratoon*(cutting most of the above-ground portion but leaving the roots and the growing shoot apices*(growing points) intact so as to allow the plants to recover and produce a fresh crop in the next season) crop may also help in disease development
- Rain, irrigation water, wind & insects also spread the disease

Epidemiology:

- 27-30°C & High RH, Humid and warm weather, water logged conditions, lack of proper cultural operations resulting in weeds, continuous cultivation of same variety in a particular locality and presence of susceptible varieties in the vicinity are the main factors determining the epidemic development of the disease.

Management:

- Crop rotation for two years
- Seed setts should be free from disease or treated with solution of Benelat for 1 hr
- Residues should be burn after harvest
- Ratoon crop discouraged if first crop infected
- Resistant thick canes varieties, particularly e.g. CP-77-400, SPF-24O, 237, CPF 72-2O86 etc.
- Treat sets with Formaline solution (1:20), or Benomyl, for10-15 minutes and cover them with wet gunny bags for 3 hours.

Tree Decline:

Description and Importance:

- Decline: Decline is term used to describe a tree that is generally deteriorating
- Serious threat to timber & fruit tree plants
- cause losses up to 50 %
- More prevalent in Shisham, Guava, Mango

Etiology:

- *Fusarium solani*
- *Botryodiplodia theobromae*
- *Phytophthora cinnamomi*

Symptoms:

- Leaves from the top start to become yellow
- Sometimes single branch shows the decline symptoms first, sometime whole plant
- Vigor of the tree is retarded*(stunted growth)
- Internal infected part of the tree show brown to gray discoloration
- Roots become black & rotten*(disintegration of cells due to pathogenic attack followed by release fluid)

Management:

- Apply balanced nutrition to the trees
- Avoid to grow crops in mango & guava orchards
- Avoid injury to the roots of the plants
- Apply irrigation water separately to each tree by making trench around the tree
- Apply Ridomil + Ca(OH)2 mixture at collar region of the tree

Citrus Wither tip

History and Importance:

Etiology:

Causal organism: *Colletotrichum gloeosporides*

Symptoms:

- Shedding of leaves and die back of twigs.
- Dead twigs give silvery appearance.
- Reddish brown stain (color) on fruit rind*(outer skin of fruit).

Disease cycle:

- Infected twigs and branches are source of infection.
- Spores spread through air to new plantation.
- Wounds provide the entry points for the pathogen.

Epidemiology:

- Temperature 22-26°C
- High relative humidity

Management:

- Pruning of infected twigs and branches followed by spray of fungicides.
- Bordeaux paste at 1:2:12, i.e. 1 kg of copper sulphate and 2 kg of lime mixed in 12 litres of water.
- Spray of 0.33% prenox.
- Spray copper based fungicides e.g. copper oxychloride 3 ml per litre of water starting in July and repeat twice with an interval of 21 days. Difenoconazole 3ml per litre of water also show good results.
- Avoid overhead irrigation

Powdery Mildew of Mango

Importance:

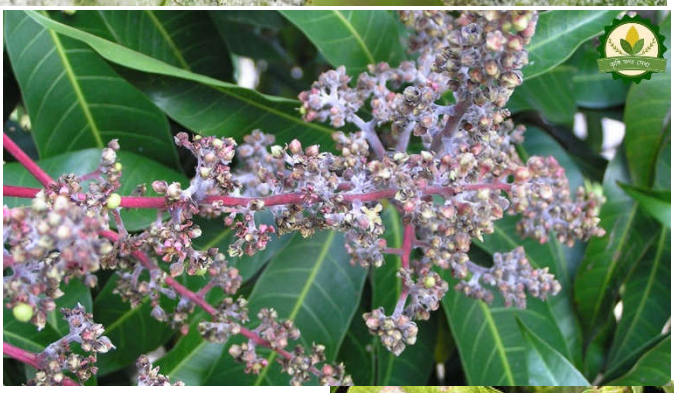
- Occurs regularly in Pakistan.
- Incidence recorded up to 100 % in some orchards

Etiology:

Causal organism: *Oidium mangiferae*
Order: Erysiphales
Family: Erysiphaceae

Symptoms:

- Small white spots on all parts of inflorescence*(the complete flower head of a plant including stalks, bracts, and flowers), leaves & fruits
- In severe cases, inflorescence completely covered by mildew (growth of fungus) & become blackened
- Young leaves curl, distorted (Twisted) & newly set fruits drop off



Disease cycle:

- Fungus survive on malformed*(mishappen)/off season panicles & mildew leaves

Epidemiology:

- Max temp 25-30°C
- Min temp 10-16°C
- 75-91 % RH

Management:

- Cut & burn infected inflorescence in Sep & Oct
- 3 spray of Benomyl (0.2%), Bavistin (0.1%) at flowering (A- pre bloom, B- full bloom, C- after fruit setting)
- A bacterium *Bacillus subtilis use as biological control*

Gram Blight

History and Importance:

- Reported in 26 countries
- In 1930s it caused total loss of crop in Spain
- In Sub-continent (Pak) appeared in epidemic form in 1922-33 & caused losses about 70 %

Etiology:

Causal organism: *Ascochyta rabei*

Symptoms:

- Circular spots appear on leaves & pods, elongated spots on petioles & stem
- Brown dots formed in the spots
- Seeds in pods may also show lesions
- In severe attack stem girdled (trapped) at base & plants die

Disease cycle:

- Survive as pycnidia on debris in soil & also on seed
- Secondary spread is through rain drops & splashes, by insects & strong wind

Epidemiology:

- High rain fall & Temp. 22-26°C are conducive for epidemic

Management:

- Removal & destruction of plant debris
- Crop rotation & deep sowing
- Intercropping with cereals
- Seed treatment with Agrosan, copper sulphate
- Spray Zineb, Mineb, Captan, Dacnil
- Resistant varieties (F-8, C-325, C-727, Kabli)

Loose Smut of Wheat

Description and Importance:

- Smut mean sooty (black) or charcoal like powder
- Responsible for heavy losses when susceptible varieties with infected seeds are grown year after year
- Cause losses 3-30 %

Etiology:

Causal organism: *Ustilago tritici*
Order: Ustilaginales
Family: Ustilaginaceae

Symptoms:

- Head of affected plants converted into black mass of spores & no grain formation
- Affected young spike lets covered by silvery membrane
- Only the awns of awned varieties escape transformation
- Spores easily separate & blown off by wind leaving bear rachis

Disease cycle:

- Air dried spores can survive for 12 months at 0-10 c
- Pathogen is internally seed-borne
- Infection occur when flowers are in full bloom & ovary is just developed after fertilization

Epidemiology:

- **Temp 22-25 °C**
- RH 60-85 %

Management:

- Solar energy treatment: Presoaking period of 4 hrs followed by 1 hr exposure to sun in summer
- Hot water treatment: 4-5 hrs in a tub at ordinary temp, at 132 F for 5 min & 132 F for 7 min
- Seed treatment with Vitavax & Baviston @ 2.5-3g/kg are systemic fungicides & effective
- Resistant varieties (Perwaz, Watan, Sehar, Shafaq)

Old Bunt of Wheat

History and Importance:

- Most serious disease of wheat in Europe in middle ages
- Also known covered smut of wheat
- Confined to cooler regions
- Difficult to threshing & reduce grain quality

Etiology:

Causal organism: *Tilletia controversra*

Order: Ustilaginales

Family: Tillitiaceae

Symptoms:

- Pistil from smutted heads become longer
- Stamens reduced in length & breadth
- Smutted ears remain dark green for longer time than normal
- Soft black pasty mass comes out if the grains are pinched with thumb & forefinger

Disease cycle:

- Primary inoculum: spores carried on seed or present in soil
- Remain viable in soil for 10 years

Epidemiology:

- High relative humidity
- Temp 18-20 °C

Management:

- Growing of resistant varieties (Perwaz, Watan, Sehar, Shafaq)
- Use disease free seed
- Seed treatment with Agrosan GN 2%, Benlate o.3%

New Bunt of Wheat (Karnal Bunt of Wheat)

History and Importance:

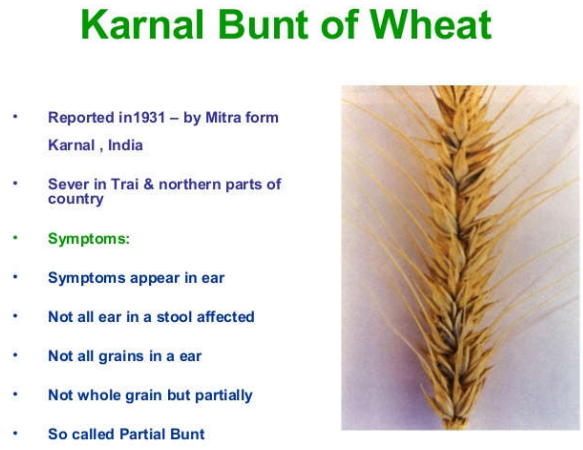
- Reported in 1931 on wheat, grown near Karnal, India
- Found in all major wheat-growing states of India, as well as in Pakistan, Iraq, Mexico, and Afghanistan
- Losses ranging from 20-40%

Etiology:

Causal organism: *Neovosia indica*
Order: Ustilaginales
Family: Tillitiaceae

Symptoms:

- Only few seeds per head infected
- Not all heads on a single plant are infected
- Disease is difficult to detect in the field
- Only a part of the germ end converted into a black powdery spore mass,
- Extreme cases, the entire kernel is converted into spores
- Rotten fish smell from the diseased field



Disease cycle:

- Smut fungus *Tilletia indica* (also known as *Neovossia indica*) spread by spores
- Spores can be carried in soil and on a variety of surfaces, including seed and other plant parts & also windborne
- Uplifted during the burning of wheat fields, and areas downwind may become contaminated if the spores remain viable

Epidemiology:

- 15–25° C, RH >82 %

Management:

- Seed treatment with PCNB and carboxin + thiram (Vitavax-Thiram)
- Disinfesting seeds in a 1.5% solution of sodium hypochlorite (i.e., 1 part of household bleach to 2 parts of water) plus Tween 20 with agitation for 10 minutes followed by rinsing
- Resistant varieties,Watan, Sehar, Bk-2000

Difference between old and new bunt

Old Bunt	New Bunt
All tillers of a plant attacked	Only few tillers attacked
Each ear is fully attacked	2-3 grains are attacked
Grains attacked as a whole	Grains partially affected
Seed borne & systemic	Infection is aerial
Found in hills	Found in plains
Distribution worldwide	In few countries
Spores smaller in size	Double in size
Sporidia are in pairs	No pairing