

Diseases of Wheat

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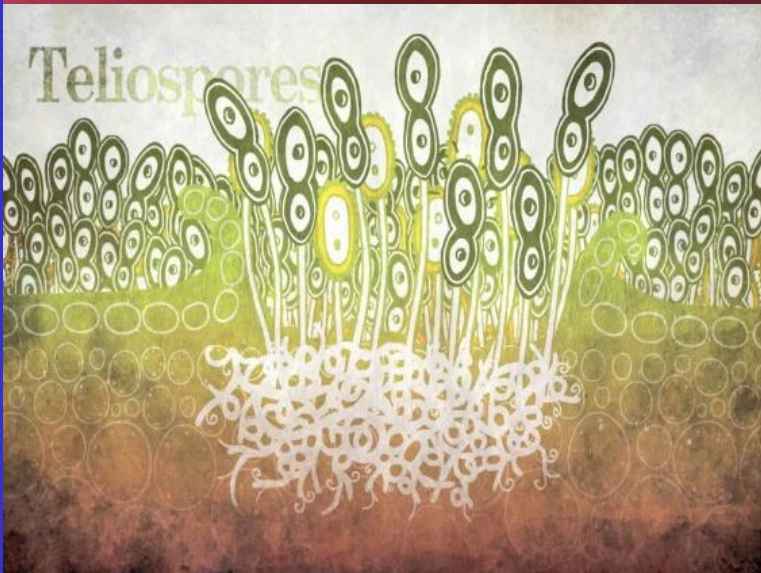
WHEAT

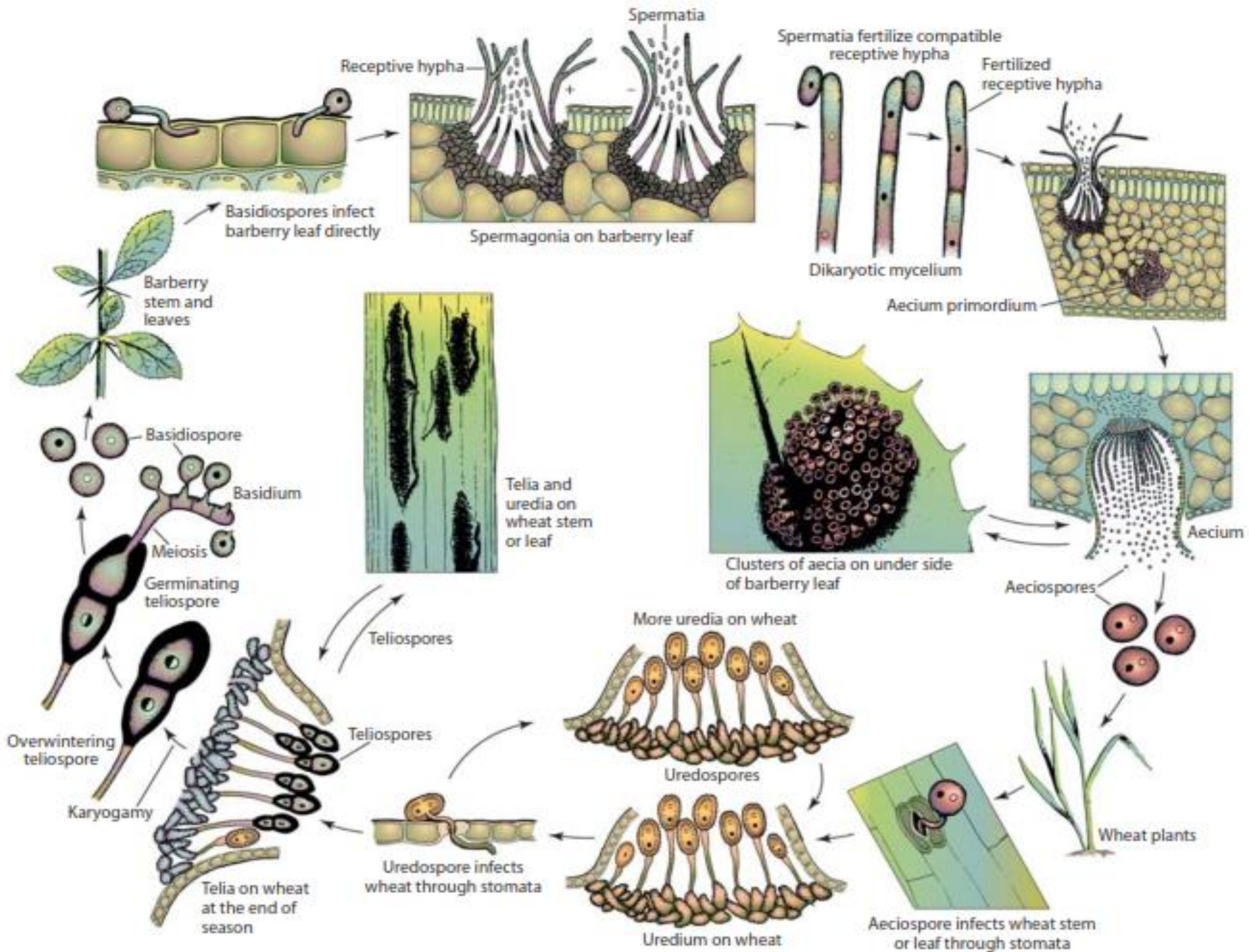
Black or stem rust	:	<i>Puccinia graminis-tritici</i>
Leaf, brown or orange rust	:	<i>Puccinia recondita</i>
Yellow or stripe rust	:	<i>Puccinia striiformis</i>
Loose smut	:	<i>Ustilago tritici</i> (<i>U. nuda tritici</i>)
Flag smut	:	<i>Urocystis tritici</i>
Rough spored bunt or stinking smut	:	<i>Tilletia caries</i>
Smooth spored bunt	:	<i>Tilletia foetida</i>
Karnal bunt	:	<i>Neovassia indica</i>
Foot rot	:	<i>Pythium graminicolum</i> and <i>P. arrhenomanes</i>
Powdery mildew	:	<i>Erysiphe graminis</i> var. <i>tritici</i>

Black stem rust	Disease
Casual organism	<i>Puccinia graminis tritici</i>
Symptoms	Seen mainly on stems than leaf sheaths and leaves. Reddish brown pustules (Uredia) appear on stems and leaves at early stage of crop and at maturity, a mixture of brown and black lesions can be seen (Telia)
Uredospores	Brown, oval, thick walled with short spines, having 4 germ pores.
Teliospores	Dark or chestnut brown, two celled, thick walled and smooth.
Mode of survival	Alternate host: <i>Berberis</i> spp. <i>Mahonia</i> spp. Uredospores and Teliospores Survive on stubbles and straws in soil and on self-sown wheat crops.

Mode of spread	Wind-borne uredospores from hills
Favourable conditions	Optimum temperature, 17-18°C during March-April in Northern India and November –December in Southern India.
Management	Mixed cropping with suitable crops. Avoid excess dose of nitrogenous fertilizers. Dust Sulphur at 35-40kg/ha. Spray Zineb at 2.5kg/ha. Grow resistant varieties like Lerma rojo, Safed Lerma, Sonalika and Chotilerma.







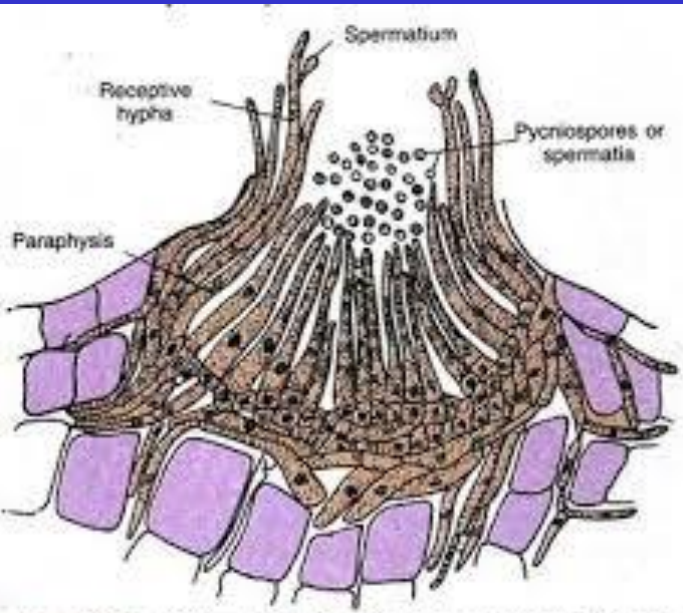
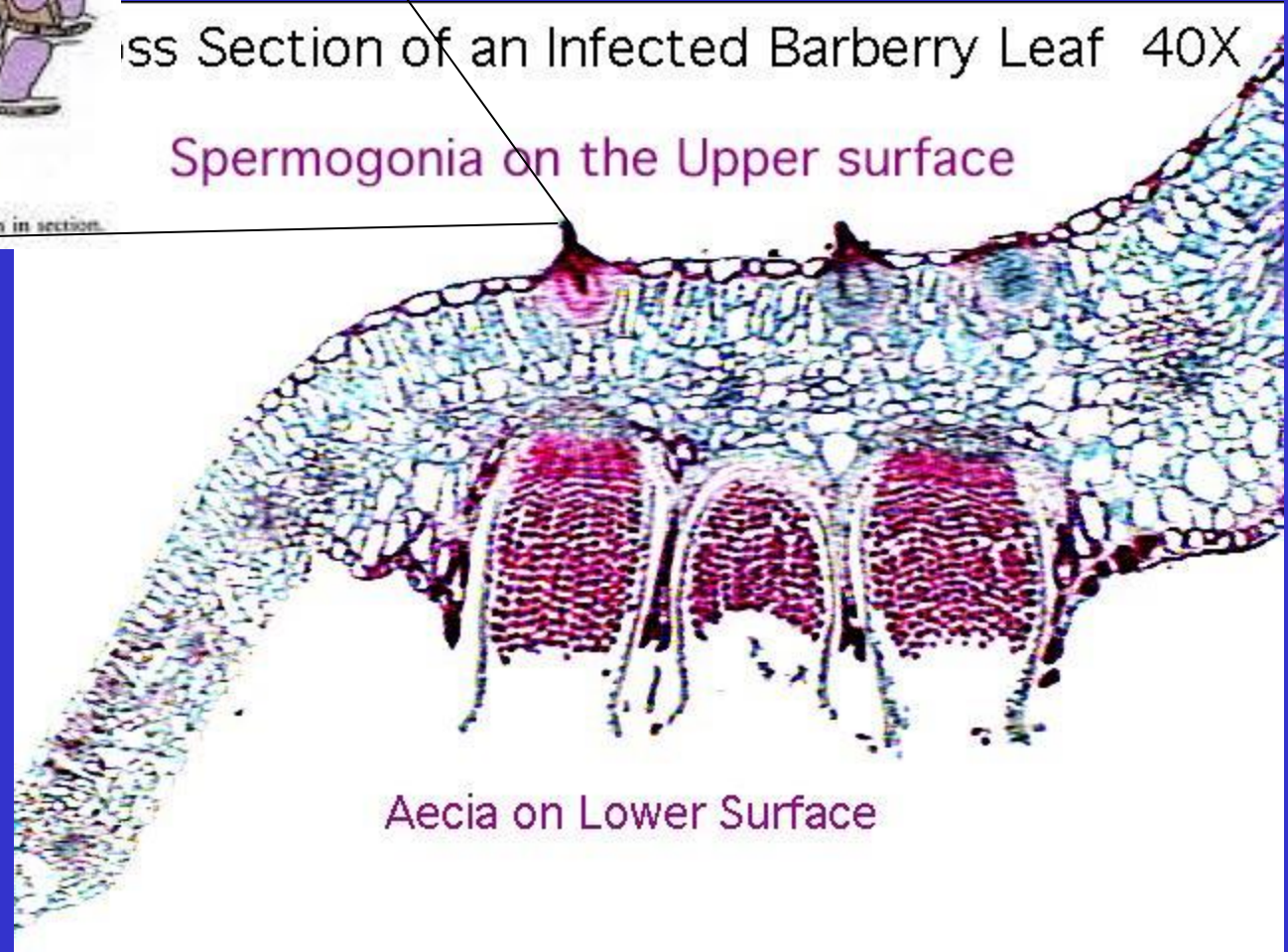


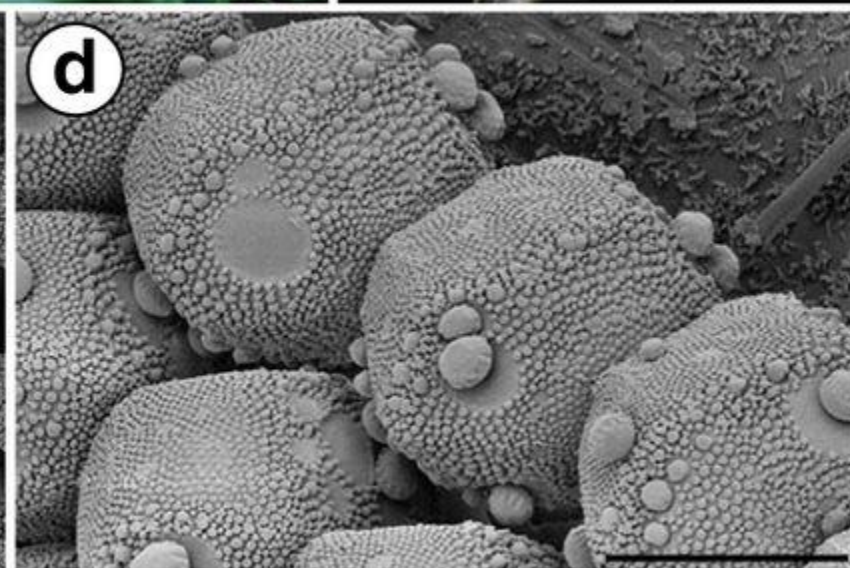
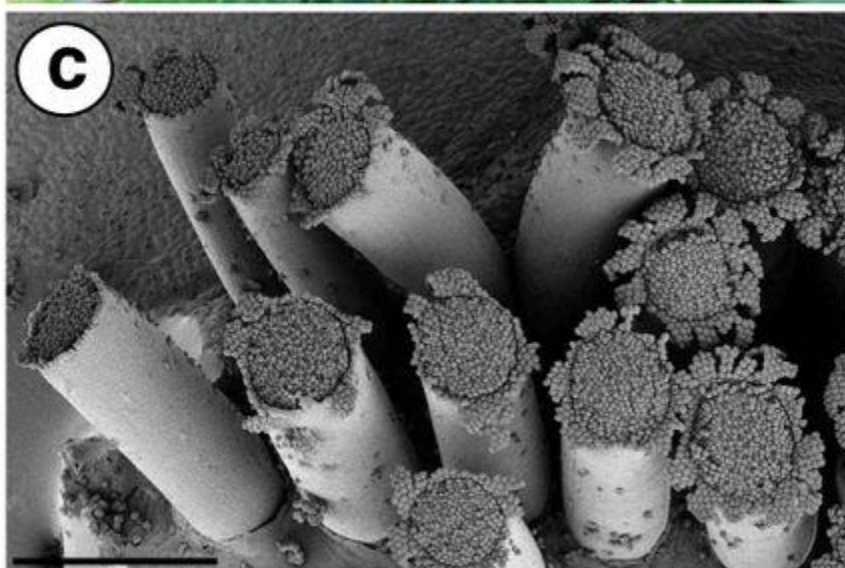
Fig. 14.18. *Puccinia graminis tritici*. A mature spermogonium in section.

Cross Section of an Infected Barberry Leaf 40X

Spermogonia on the Upper surface



Aecia on Lower Surface



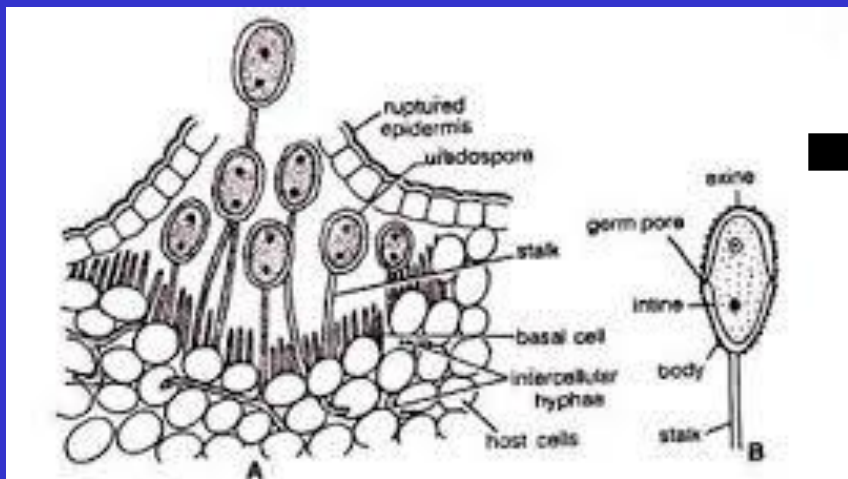
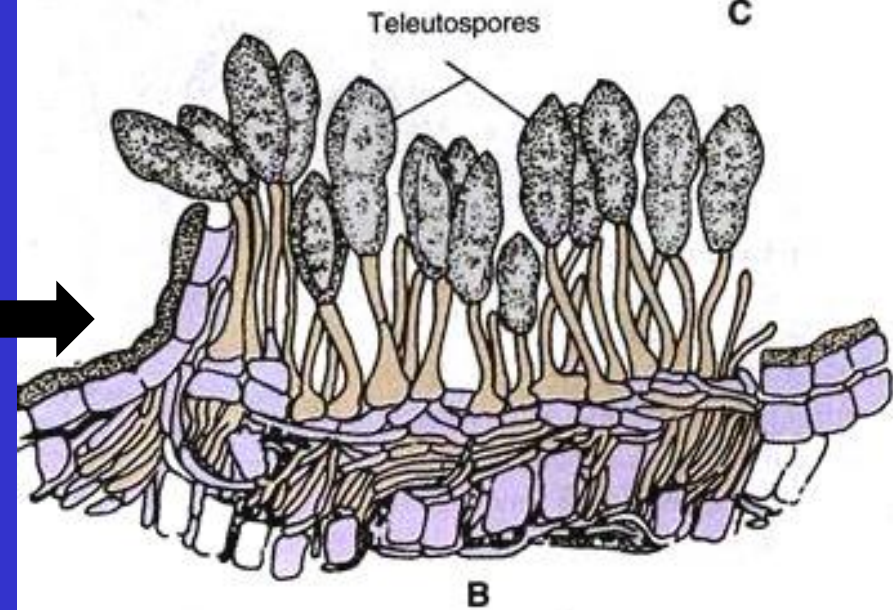
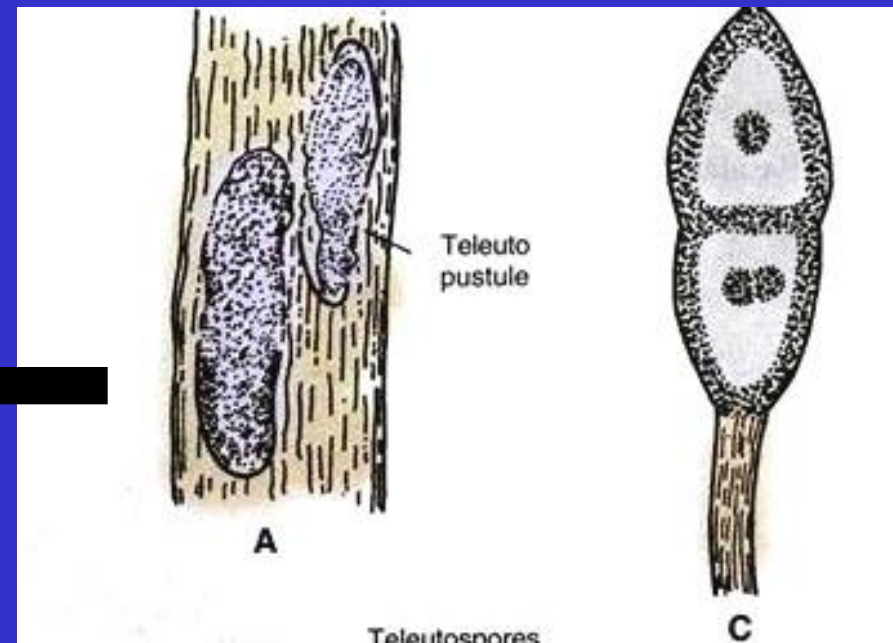
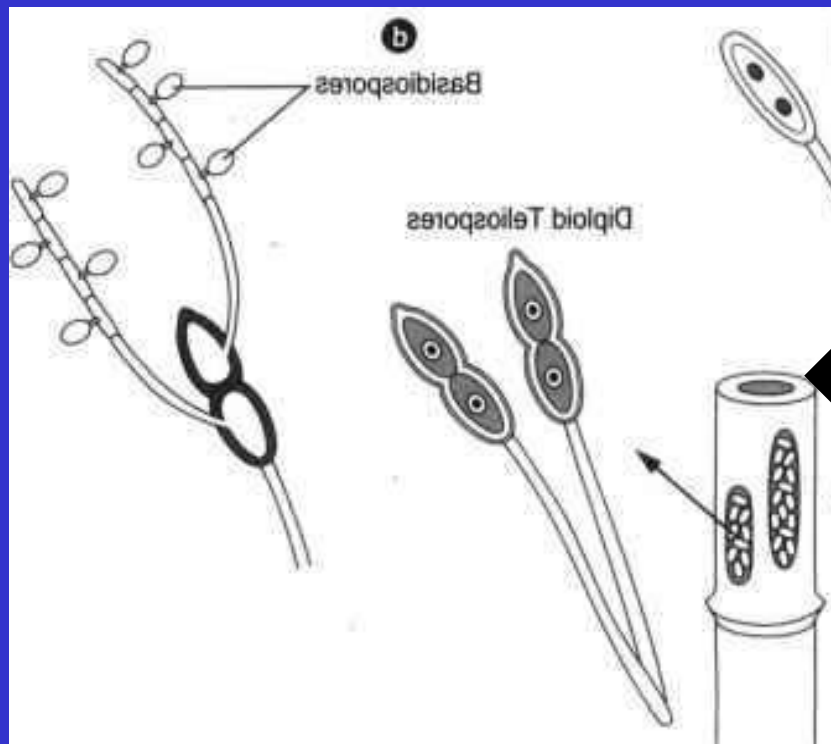
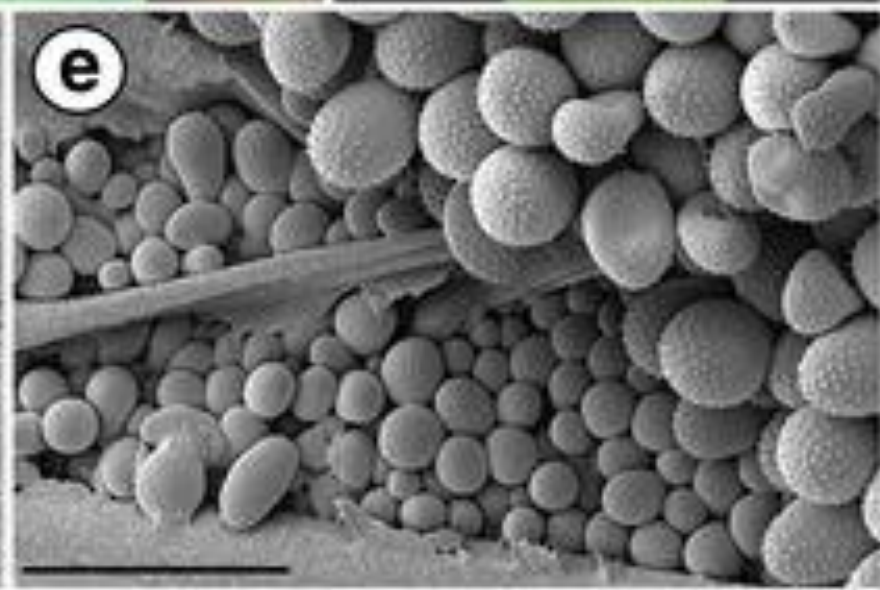
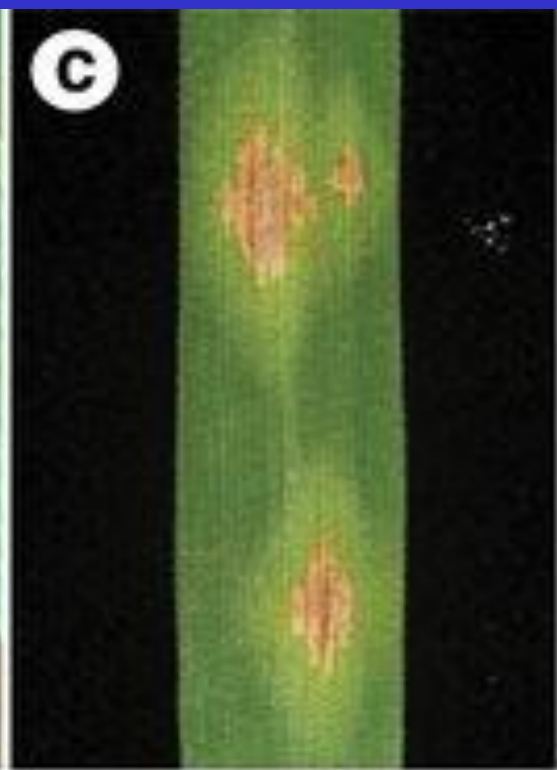


Fig. 4 (A-B). *Puccinia graminis* : T.S. wheat leaf passing through a uredosorus, (B) A uredospore

Fig. 14.16 (A-C). Telial stage of *Puccinia graminis tritici*. A, Teleutostome on wheat; B, A section through the teleutosorus; C, Single teleutospore with a fusion nucleus in each cell.



STEM RUST



Uredinia



Urediniospores (400x)



Telia



Teliospores (400x)

Orange brown leaf rust

P. recondita

Yellow stripe rust

P. striiformis



Orange rust



Yellow stripe rust



P. recondita



Orange rust

Mainly seen on leaves, rarely on leaf sheath and very rarely on stem. Rust pustules (Uredia) appear on leaves at early stage of crop and at maturity they turn to brown or orange (Telia)

Brown, spherical, minutely echinulated with 7-10 germpores.

Brown, two celled, smooth, thick walled with rounded apex.

Alternate host: *Thalictrum* sp. Uredospores and dormant mycelium persist on crop debris and weed hosts.

Yellow rust

Mainly occur on leaves than the leaf sheaths and stem. Bright yellow pustules (Uredia) appear on leaves at early stage of crop and at maturity, pustules are arranged in linear rows along with dull black lesions (Telia) and hence the name stripe rust.

Yellow, spherical to oval, minutely echinulated with 6-16 germ pores.

Dark brown, two celled, thick walled and flat at the top.

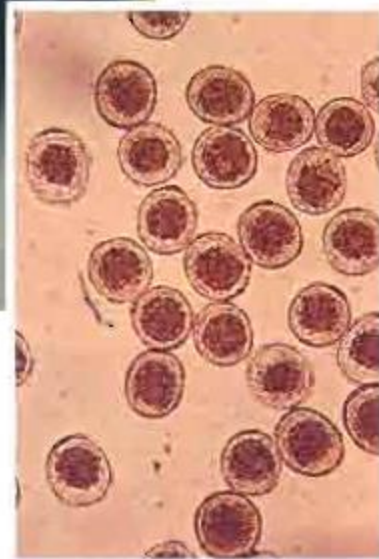
Alternate host: Unknown. Uredospores and dormant mycelium survive on stubbles and straws and also on weed hosts and self-sown wheat crops.

Wind-borne uredospores from hills	Wind borne uredospores from hills.
Warm weather (15°C) and heavy rain during January	Very low temperature (11°C) and heavy rainfall during November-December.
Mixed cropping with suitable crops. Avoid excess dose of nitrogenous fertilizers. Dust Sulphur at 35-40g/ha. Spray Zineb at 2.5kg/ha. Grow resistant varieties like Lerma Rojo, Safed Lerma, Sonalika and Chotilerma.	Mixed cropping with suitable crops. Avoid excess dose of nitrogenous fertilizers. Dust Sulphur at 35-40kg/ha. Spray Zineb at 2.5kg/ha. Grow resistant varieties like Lerma Rojo, Safed Lerma, Sonalika and Chotilerma.
Alternate host: <i>Thalictrum</i> sp. Uredeospores and dormant mycelium persist on crop debris and weed hosts.	Alternate host: Unknown. Uredospores and dormant mycelium survive on stubbles and straws and also on weed hosts and self-sown wheat crops.

LEAF RUST



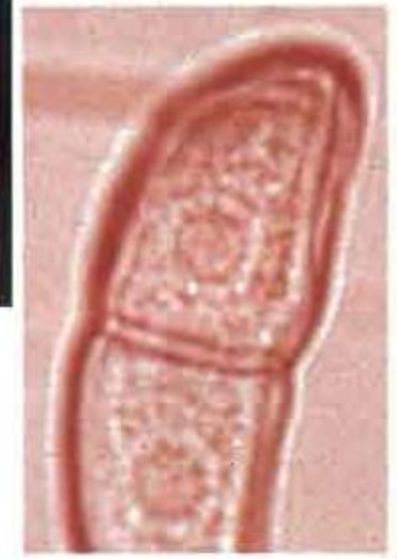
Uredinia



Urediniospores (400x)



Telia



Teliospores (400x)

STRIPE RUST



Uredinia



Urediniospores (400x)



Uredinia in the spikelets



Teliospores (400x)

- **Resistant varieties**
- **Lerma Rojo, Safed Lerma, Sonalika and Chotilerma**
- **Mixed cropping and crop rotation**
- **Avoid excess “N”**
- **Sulphur dusting @ 35-40 kg/ha**
- **Zineb spray @2.5 kg/ha**

Disease	Loose smut	Flag smut
Casual organism	<i>Ustilago nuda-tritici</i>	<i>Urocystis tritici</i> <i>Syn: Urocystis agropyri</i>
Symptoms	Symptom is visible only after emergence of ear. Diseased ear heads emerge out of the boot leaf earlier than healthy ones. The smutted spikelet is covered by a silvery membrane which contain black, dry powdery mass of spores.	The symptom can be seen on stem, culm and leaves from late seedling stage to maturity. The seedling infection leads to twisting and drooping of leaves followed by withering. Grey to greyish black sori occur on leaf blade and sheath. The sorus contains black powdery mass of spores.

Spores	Smut spores are pale, olive brown, spherical to oval in shape with minute echinulations. Spores germinate to produce four celled promycelium with sporidia.	Aggregated sporeballs consisting 1-6 bright globose, brown, smooth walled spores surrounded by a layer of flat sterile cells.
Mode of spread and survival	Internally seed borne as dormant mycelium (Embryo infection)	Seed and soil borne. Smut spores are viable for more than 10 years.
Favourable conditions	Temperature of 18-20°C. High humidity (60-85 per cent) during flowering	Temperature of 18-24°C. Relative humidity 65 percent and above.

Management	<p>Hot water treatment: Soak the seeds in water at 26-30°C for 5hrs to induce dormant mycelium to grow. Then immerse the seeds in hot water at 54°C (129°F) for 10min to kill the mycelium.</p> <p>Solar treatment: Soak the seeds in cool water for 4 hours in the forenoon followed by spreading and drying of seeds in bright sun (44°C) for 4 hours in the afternoon. Treat the seed with Carboxin or Carbendazim at 2g/kg. Grow resistant varieties like Kalyan 227, PV18, WG307 and C302.</p> <p>Spraying of Triadimefon Triadimenol</p>	Treat the seeds with sulphur or Carboxin at 2g/kg. Grow resistant varieties like Pusa 44 and WG 377.
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Loose smut



Loose smut



Loose smut

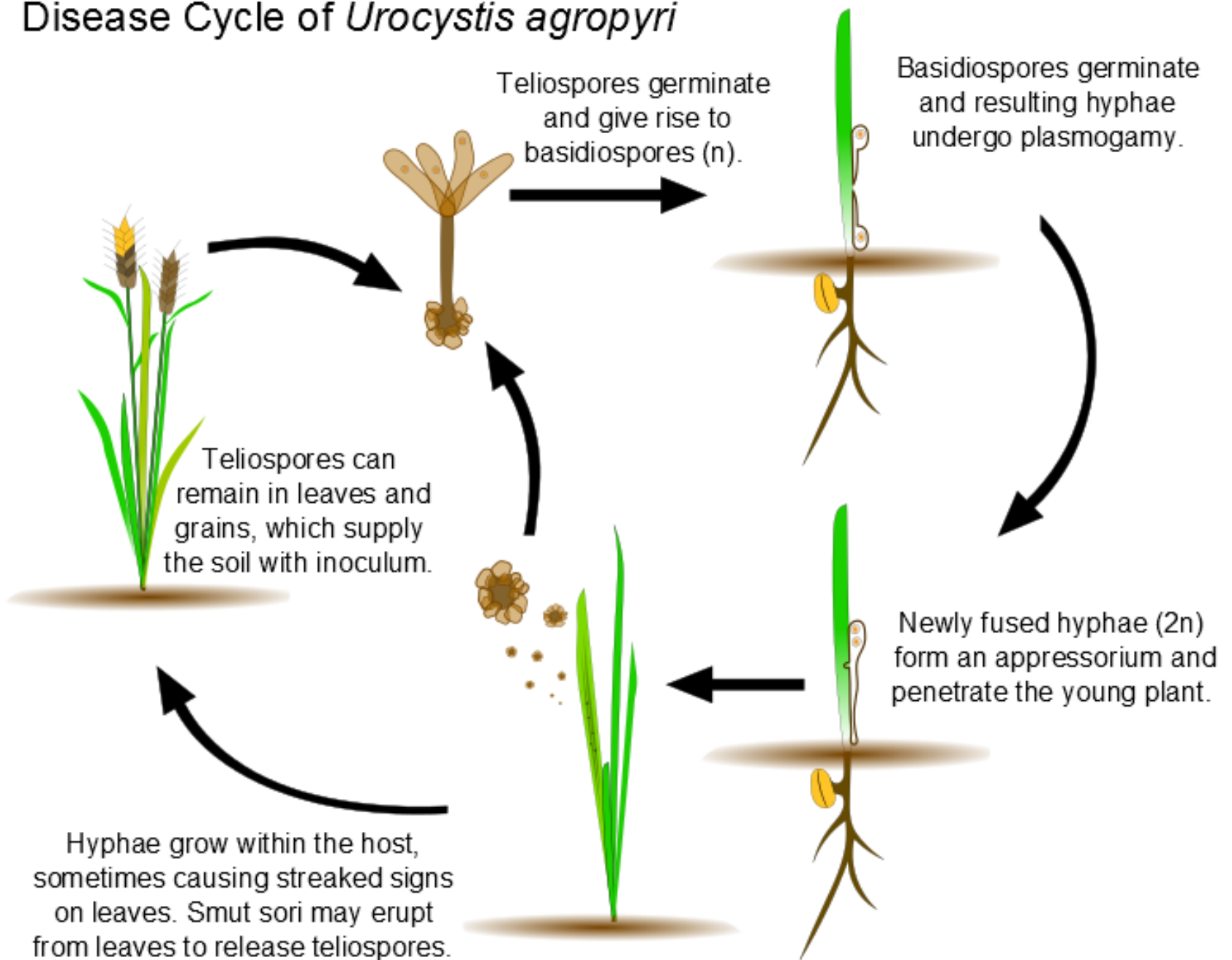


Flag smut

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Disease Cycle of *Urocystis agropyri*



Common and Dwarf Bunt (Stinking Smut/ European Bunt/ Hill Bunt)

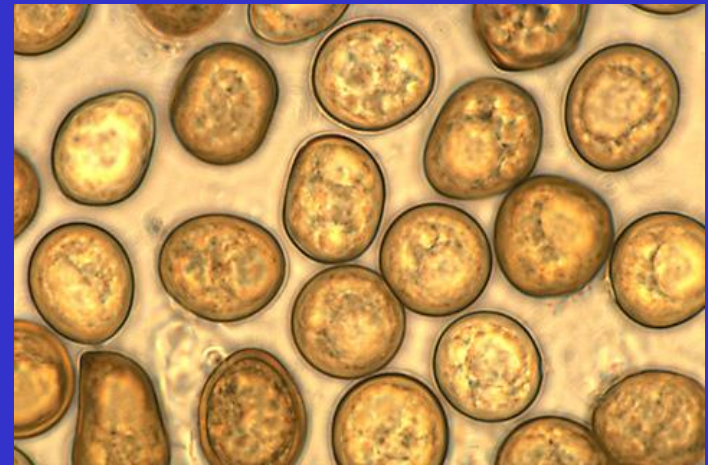
Tilletia caries, *T. foetida*, *T. controversa*



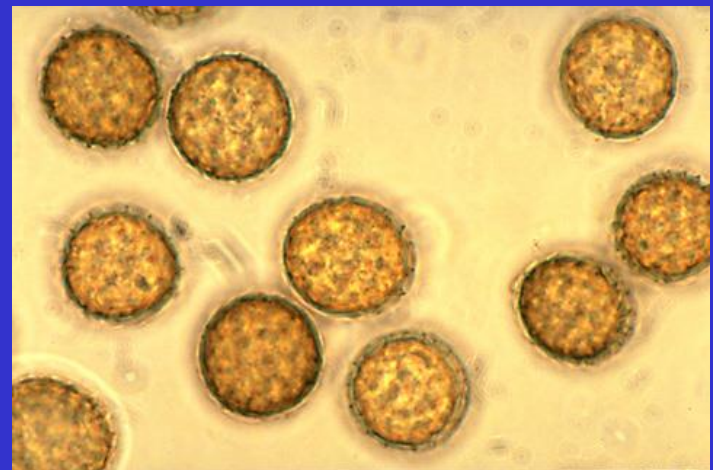
Symptoms: The main symptoms caused by these three species are fungal structures called "**bunt balls**," which resemble kernels but are completely filled with black teliospores.

The bunt balls of common bunt, caused by *T. caries* and *T. foetida*, are about the same size and shape as the kernels they replace ; those of dwarf bunt, caused by *T. controversa*, are more nearly spherical

Stinking Smut



T. tritici (syn. *T. caries*)



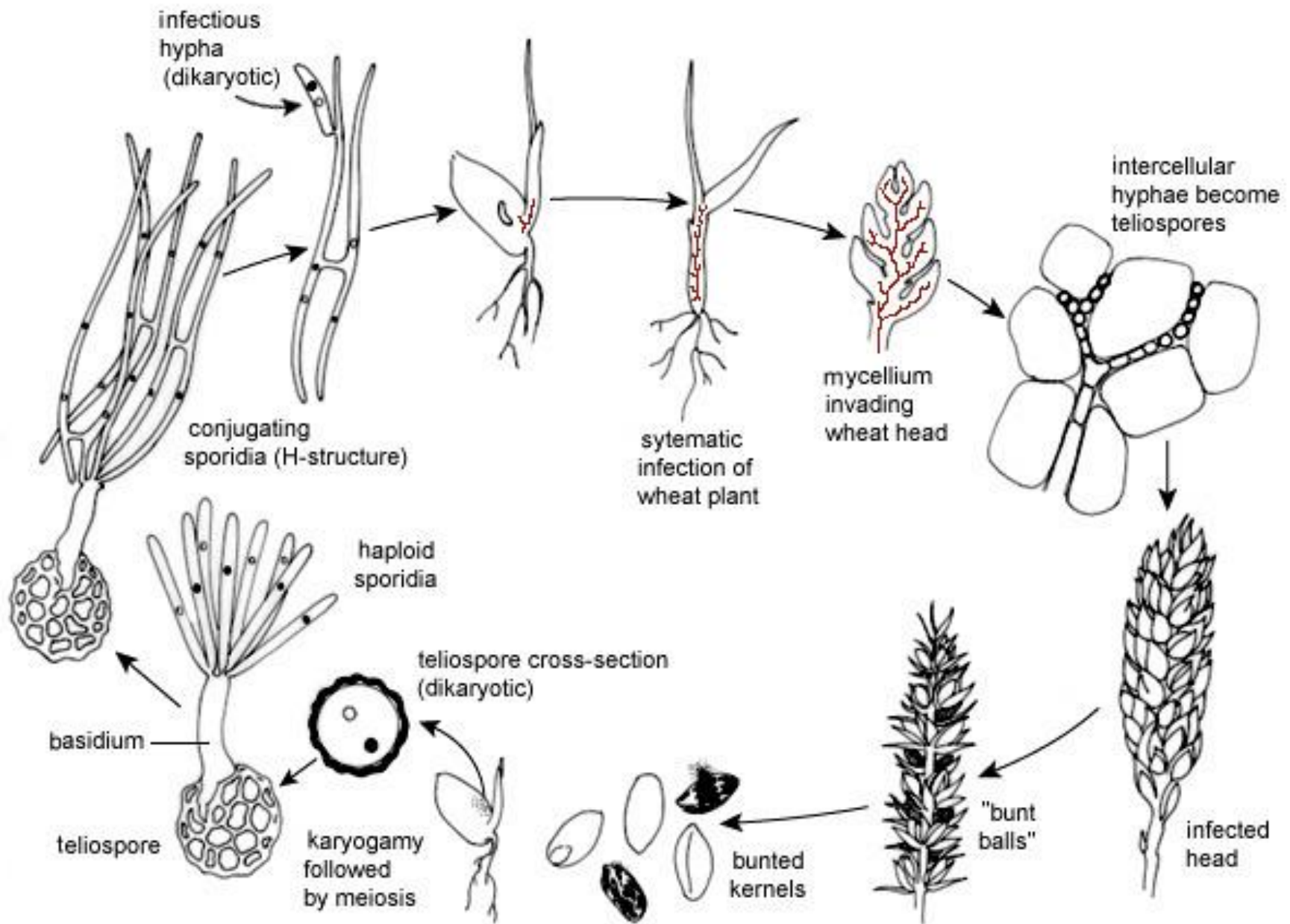
T. laevis (syn. *T. foetida*)

Bunt or Stinking Smut



**Dwarf bunt
(*Tilletia controversa*)
causing
dwarfing in
bearded wheat
crop**





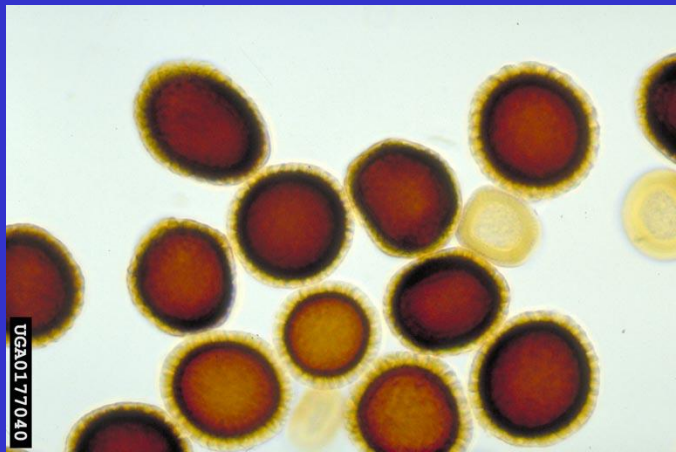
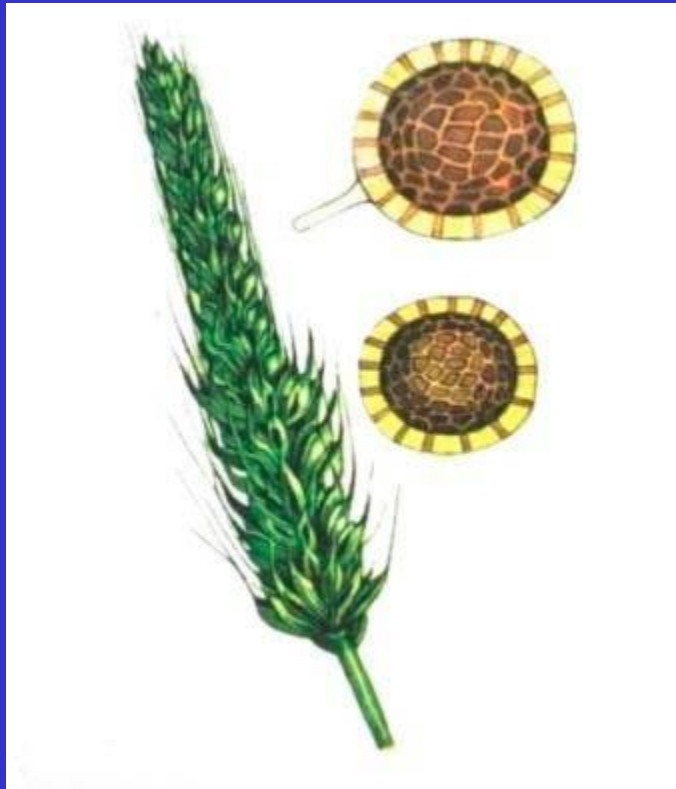
Disease	Rough spored bunt or stinking smut
Casual organism	<i>Tilletia caries</i>
Symptoms	The fungus attacks seedling of 8-10 days old and become systemic and grows along the tip of shoot. At the time of flowering hyphae concentrate in the inflorescence and spikelets and transforming the ovary into smut sorus of dark green colour with masses of chlamydospores. The diseased plants mature earlier and all the spikelets are affected.
Spores	Reticulate, globose and rough walled. Germinate to produce primary sporidia which unite to form 'H' shaped structure.
Mode of spread	Externally seed-borne
Favourable conditions	Temperature of 18-20°C. High soil moisture

Management	Treat the seeds with Carboxin or Carbendazim at 2g/kg. Grow the crop during high temperature periods. Adopt shallow sowing. Grow resistant varieties like Kalyan sona, S227, PV18, HD2012, HD4513 and HD4519.
Smooth spored bunt	Karnal bunt
<i>T.foetida</i>	<i>Neovassia indica</i>
The fungus attacks seedling of 8-10 days old and become systemic and grows along the tip of shoot. At the time of flowering, hyphae concentrate in the inflorescence and spikelets and transforming the ovary into smut sorus of dark green colour with masses of chlamydospores. The diseased plants mature earlier and all the spikelets are affected.	The infection occurs only at the flowering stage from airborne sporidia released from smut spores in soil. Only a few spikelets are converted into dark coloured sori.

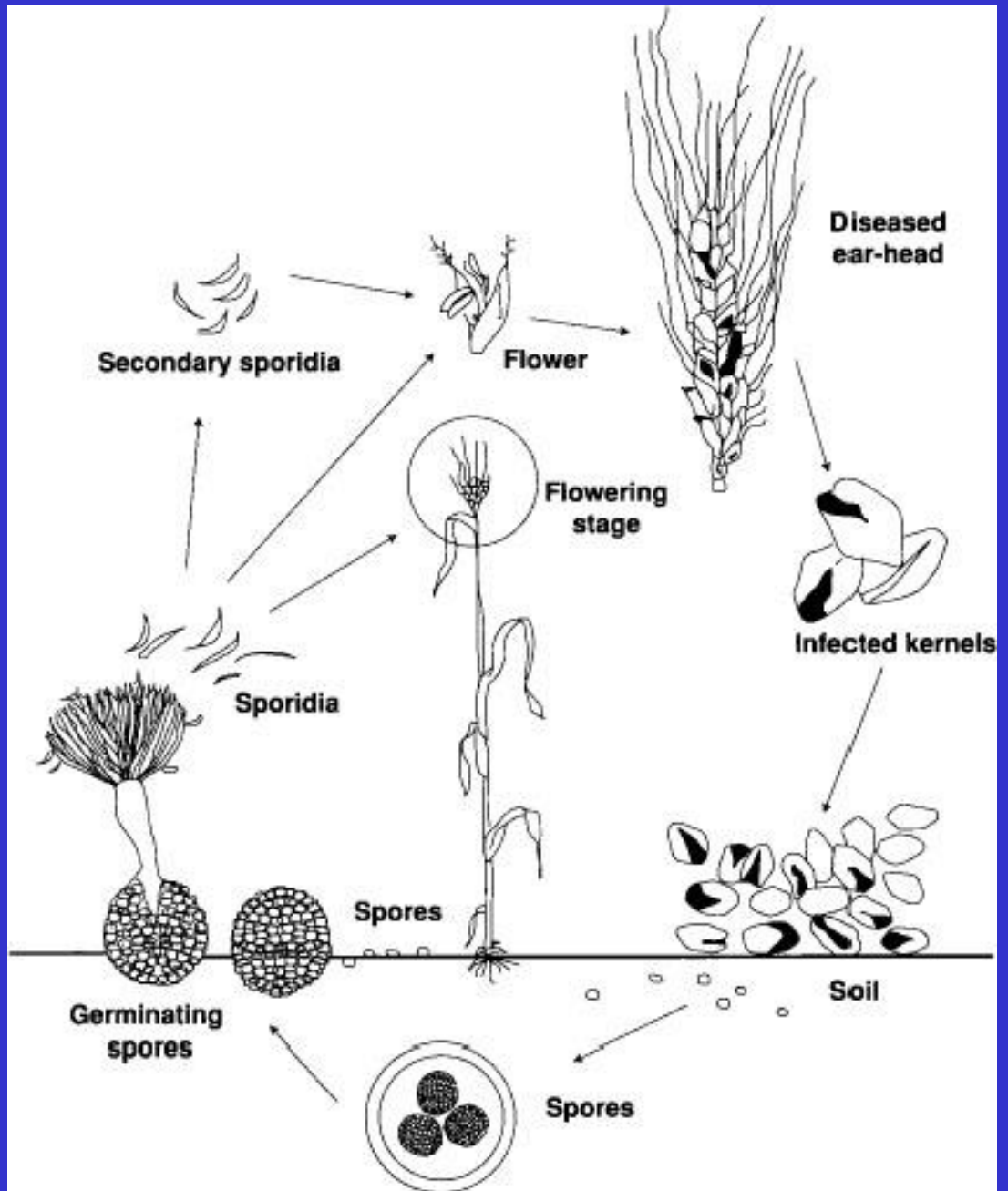
<p>Reticulate, globose and smooth walled. No resting period. Produce primary sporidia upon germination, which unit to form 'H' shaped structure.</p>	<p>Globose and smooth walled. Long resting period. Germinate to produce primary sporidia which are needle shaped and then secondary sporidia which are sickle shaped.</p>
<p>Externally seed-borne</p>	<p>Soil-borne and air-borne</p>
<p>Temperature of 18-20°C. High soil moisture</p>	<p>Temperature of 15-20°C. High humidity, cloudy weather during flowering.</p>
<p>Treat the seeds with Carboxin or Carbendazim at 2g/kg. Grow the crop during high temperature periods. Adopt shallow sowing. Grow resistant varieties like Kalyan sona, S227, PV18, HD2021, HD4513 and HD4519.</p>	<p>Deep ploughing during summer. Avoid continuous cropping of wheat in the same field. Grow resistant varieties like HD1907, HI358, HP743, L176, L191 and M-137-A.</p>

Karnal bunt on wheat kernels





UGA0177040



Powdery mildew

Erysiphe graminis var. tritici

Symptom

Greyish white powdery growth appears on the leaf, sheath, stem and floral parts. Powdery growth later become black lesion and cause drying of leaves and other parts.

Fungus produces septate, superficial, hyaline mycelium on leaf surface with short conidiophores. The conidia are elliptical, hyaline, single celled and thin walled. Dark globose cleistothecia containing 9-30 asci develop with oblong, hyaline and thin walled ascospores.





Mode of spread and survival

Fungus remains in infected plant debris as dormant mycelium and asci. Primary spread is by the ascospores and secondary spread through air borne conidia.

Favourable conditions:

Temperature of 20-21°C.

Management:

Dust sulphur at 40kg/ha. Spray 1% thiosulphate.

Leaf blight: *Alternaria triticina*

Symptoms

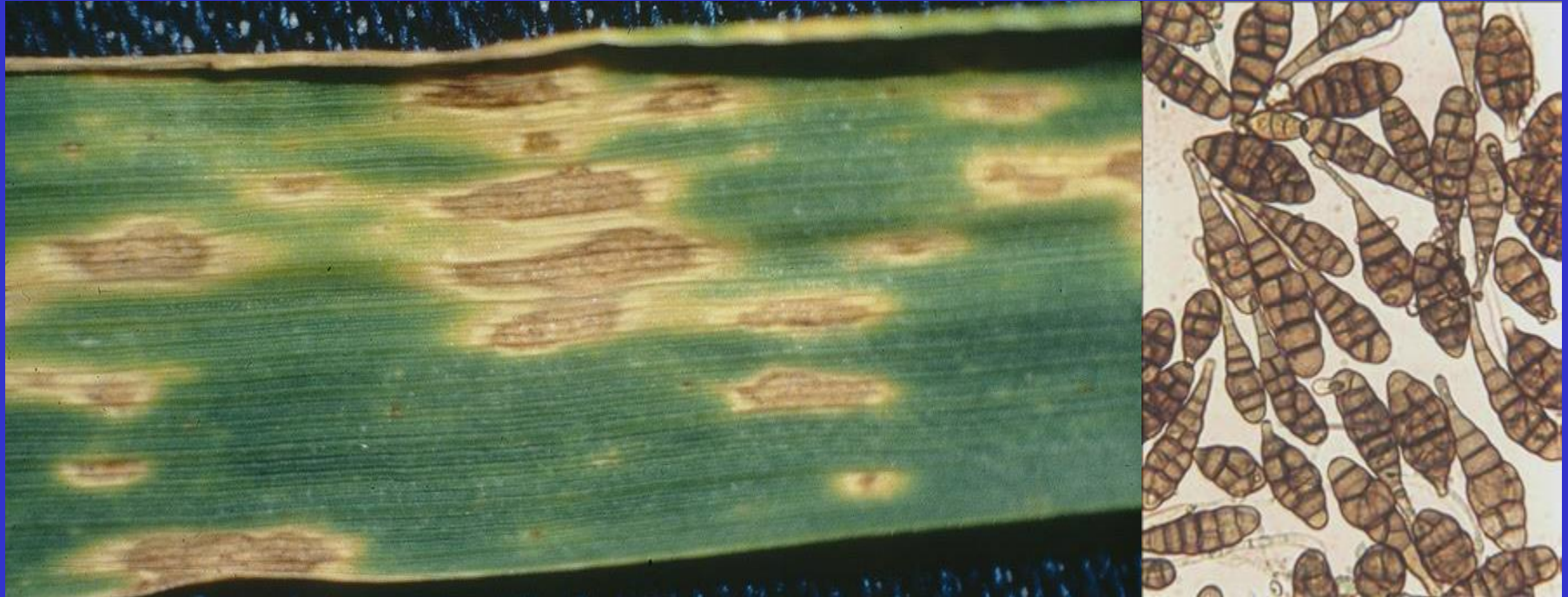
Reddish brown oval spots appear on young seedlings with bright yellow margin. In severe cases, several spots coalesce drying of leaves. Fungus produces light brown coloured multicellular conidia singly or in chain.

Mode of spread and survival

Primary spread is by externally and internally seed-borne conidia. Secondary spread by air-borne conidia.

Favourable conditions

Temperature of 25°C and high relative humidity



Management

Soak the seeds in water for 4 hrs followed by 10 min. dip in hot water at 52°C. Grow resistant varieties like Arnautka, E6160 and K7340.

Spray the crop with Mancozeb or Zineb at 1.5kg/ha.

Tundu or Yellow Ear Rot :

Due to combined action of wheat nematode *Anguina tritici* and the bacterium *Corynebacterium tritici* – *Clavibacter tritici*.

SYMPTOMS:

Yellow slime on the stem and inflorescens

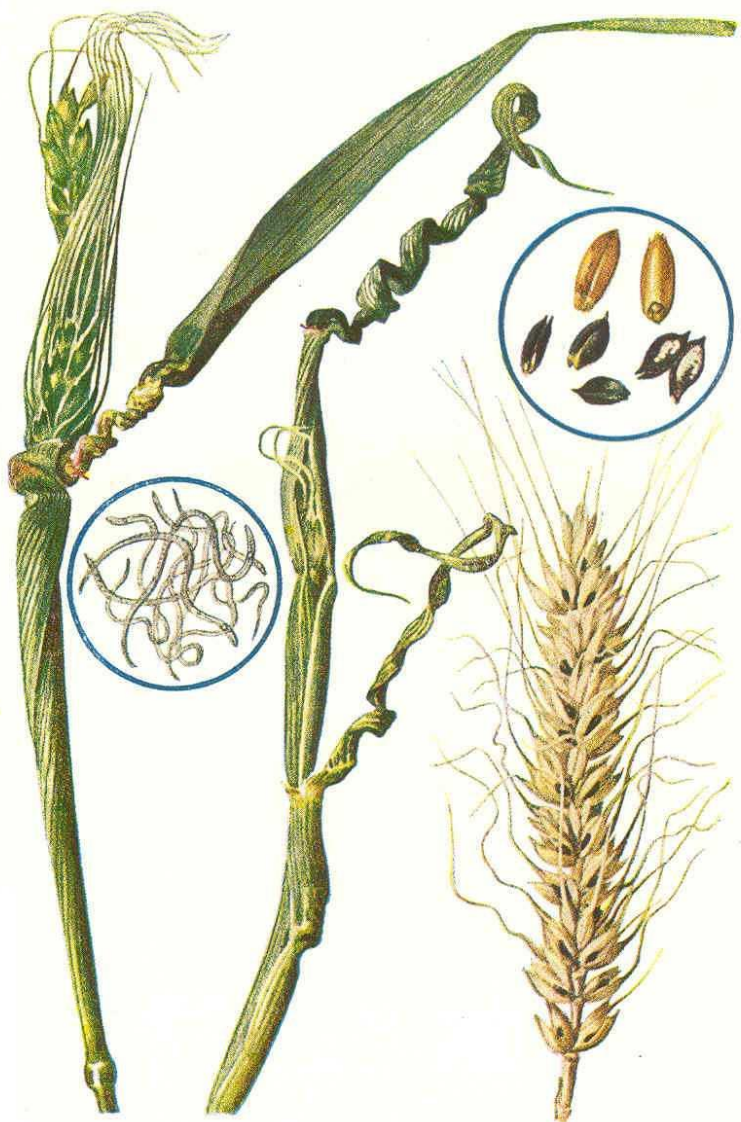
Slime dries up to form sticky yellow layers and cause curling, twisting and distortion of ear heads and rotting of the spikes.

Most of the grains in the earhead are replaced by galls formed by the nematodes and galls carry bacterium

MANAGEMENT : Soaking seed in brine solution (14.5kg/450l) by floating separate the galls

**DISEASE KNOWN AS EAR COCKLE DISEASE AND
WHEN NEMATODE ASSOCIATED WITH BACTERIUM
CAUSE VERY SEVERE DAMAGE**

Tundu or Yellow Ear Rot



Bacterial spike blight in wheat



Yellow ear-rot on deformed head





Foot rot (*Fusarium culmorum* & *Pythium graminicolum*)





brown foot rot fungi is *Microdochium nivale*



Flag leaf infections *Microdochium nivale*

Leaf Blotch of Wheat and Barley

Mycosphaerella graminicola (*Septoria tritici*)

Leptosphaeria nodorum (*Stagnospora nodorum*)

Leptosphaeria avenaria f.sp. *triticea* (*S. avenae* f.sp. *triticea*)

Irregular- oval to elongated chlorotic spots.

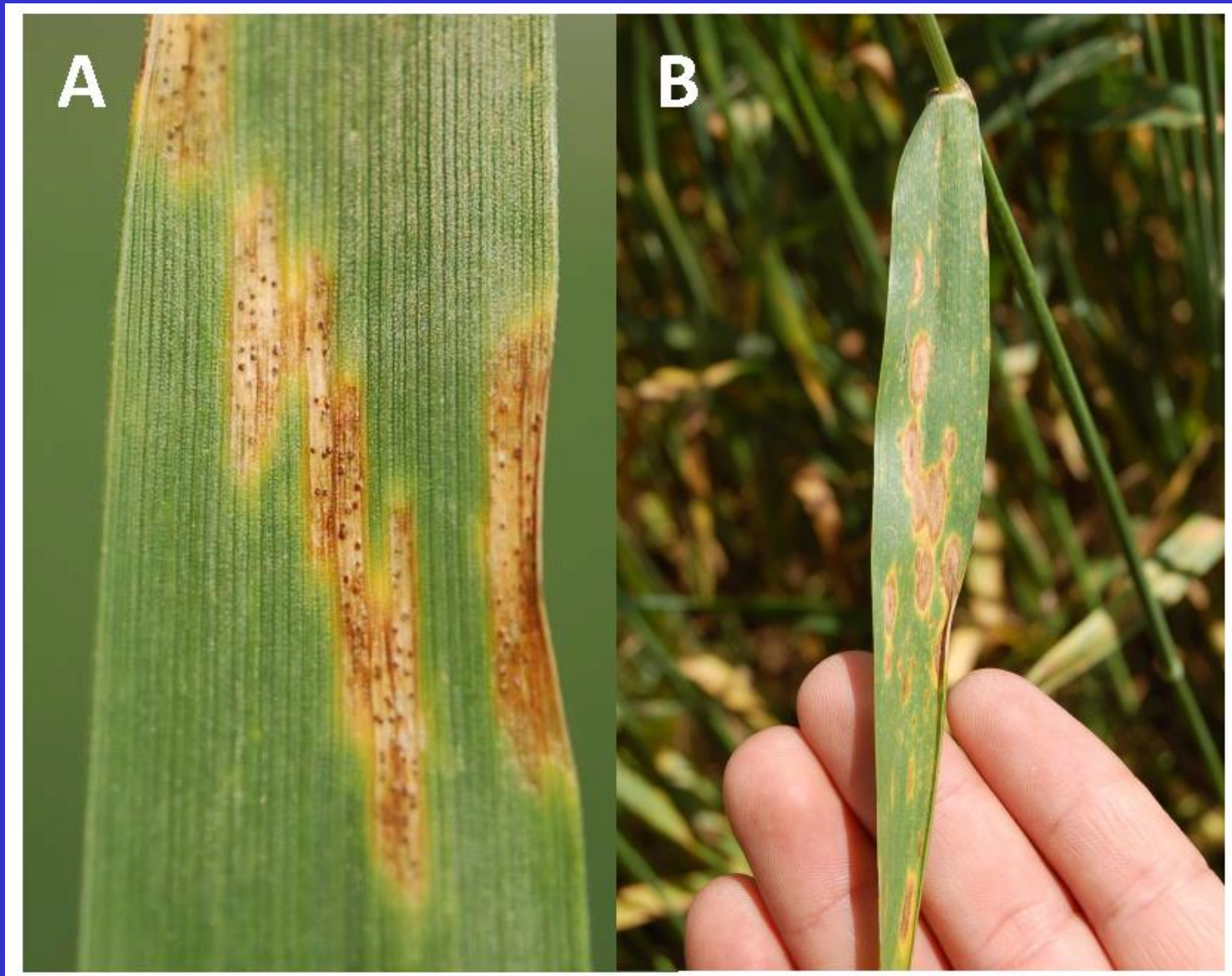
Centers of the lesions become pale, straw colored, and slightly necrotic, often with numerous small black dots (pycnidia).

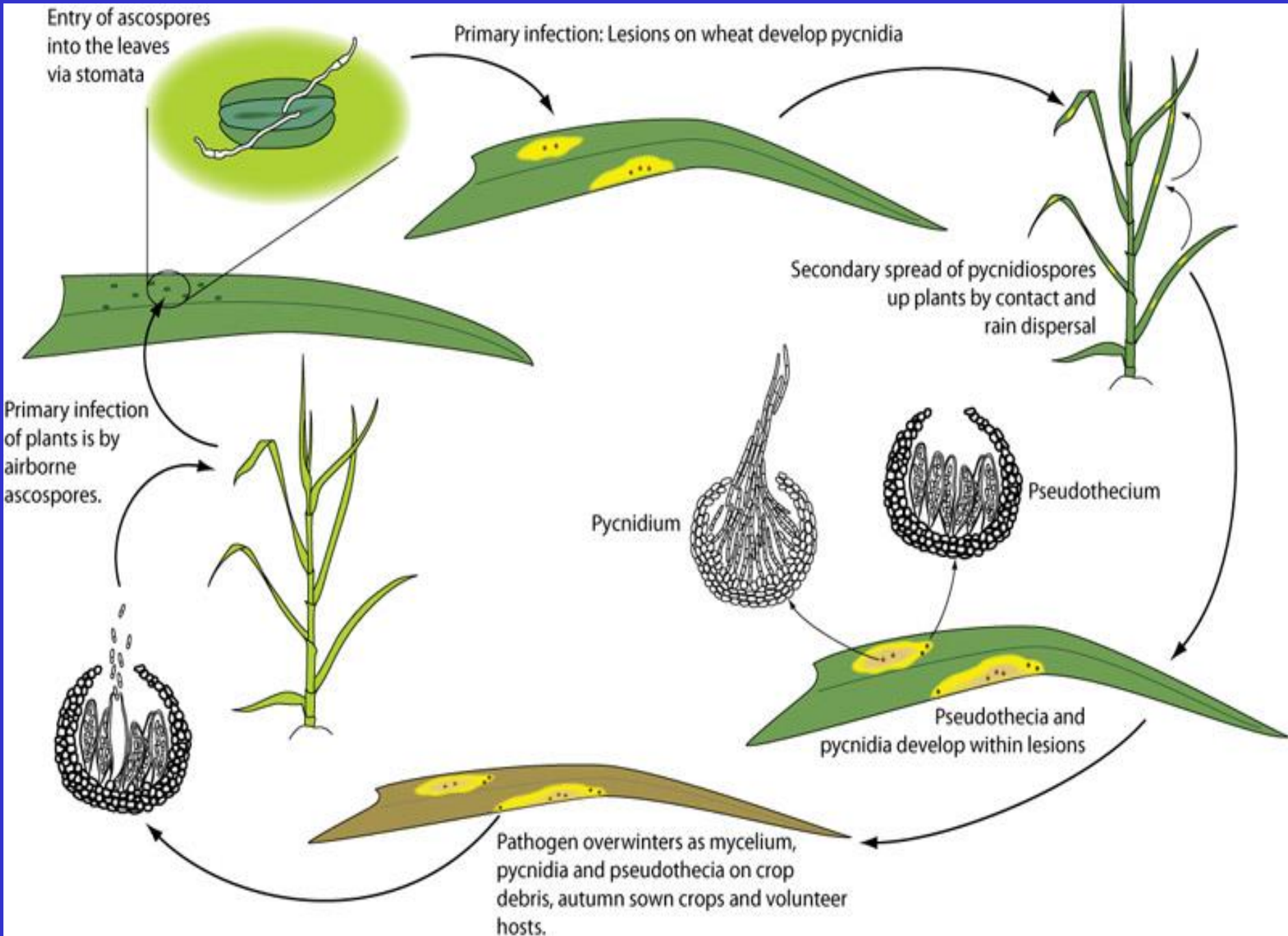
The lesions of *Septoria tritici* blotch tend to be linear and restricted laterally .

Septoria nodorum and *Septoria avenae* blotch are more lens shaped, heavy infection can kill leaves, spikes or even the entire plant.

Identification of species in the field can be difficult, and microscopic examination is often necessary.

**A, *Septoria tritici* blotch with distinct black pycnidia and
B, *Stagonospora nodorum* blotch.**





Bacterial Black Chaff and Bacterial Stripe

Xanthomonas campestris pv. *translucens* Syn. *X. translucens*, *X. translucens* f. sp. *undulosa*, *X. campestris* pv. *undulosa*



Basal Glume Rot and Bacterial Leaf Blight

Pseudomonas syringae pv. *atrofaciens*
Syn. *Pseudomonas atrofaciens*



Yellow rust: *Puccinia striiformis hordei* (stripe rust)-

Yellow rust is the disease of cool temperature (10 –20°C) and the availability of free moisture is further congenial to spread infection. The narrow stripes containing yellow to orange yellow colour pustules on leaf sheaths, necks and glumes appears in the stripe rust.

Leaf rust (brown rust)

Puccinia hordei :-

In case of leaf rust, the symptom appears randomly on upper surface of leaf and leaf sheaths and occasionally on neck and awns as small orange/ orange brown pustules, primarily. The temperature requirement is between 20-25°C.



Stem rust (black rust) *Puccinia graminis*

Stripe, Stem and Brown rusts

Leaf blight/ Spot blotch *Bipolaris sorokiniana*:

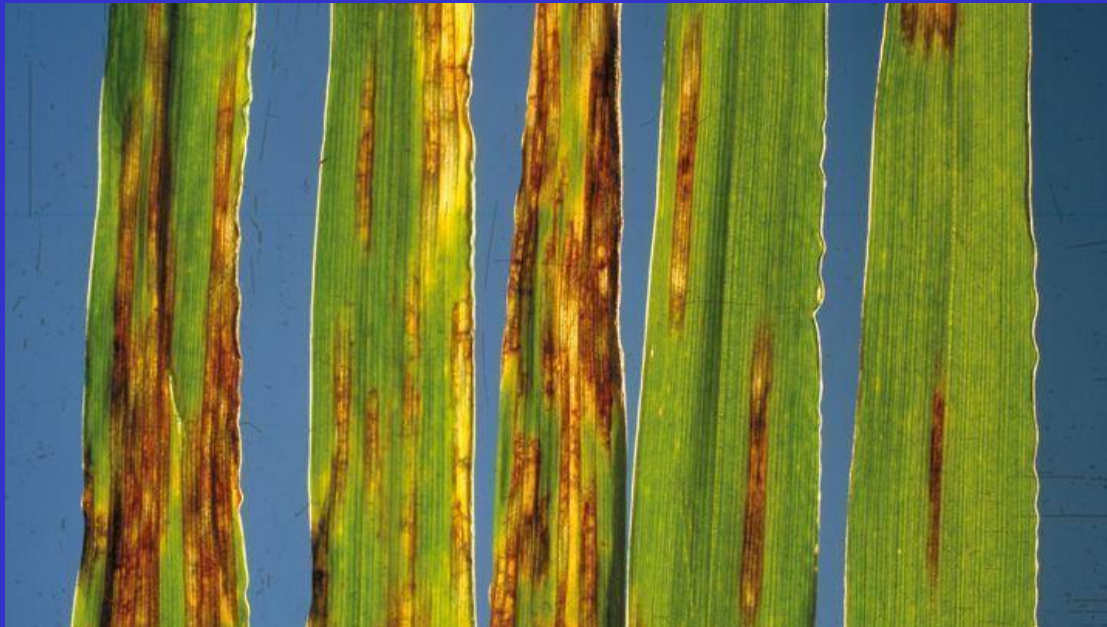
Leaf blight in barley is caused by *Bipolaris sorokinina*.

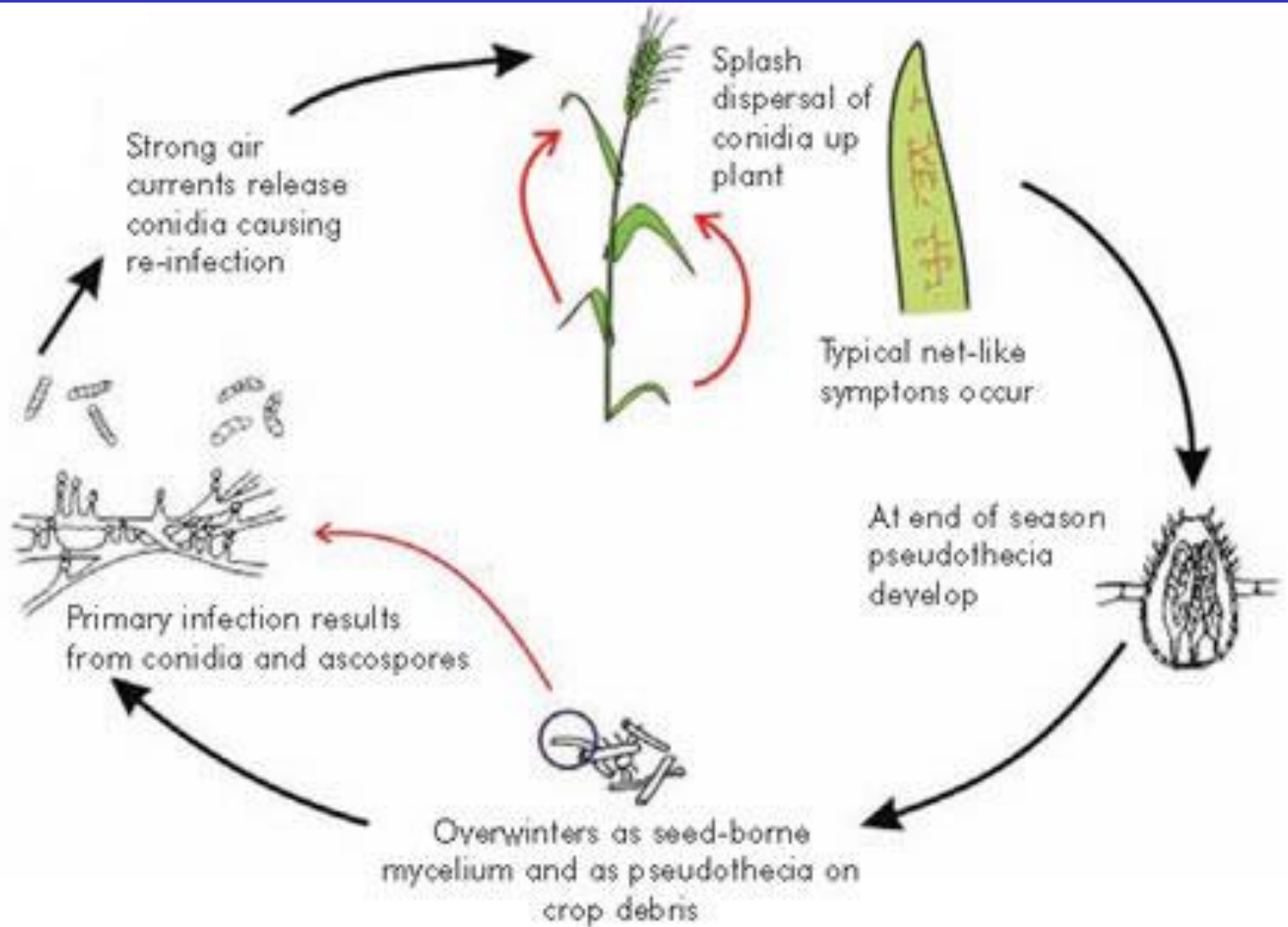
- The disease spreads as small light brown spindle spots distributed on leaf blade increasing in size along the leaf veins.
- The spots are irregular and vary from oval to oblong or elliptical.
- Fully developed lesions become dark brown colour and cover entire leaf by merging together.



Net Blotch: *Drechslera teres*

- In general, net blotch is not prevalent as leaf blight but is an emerging disease in north eastern plains zone.
- It appears as small circular brown spots that develop into a chocolate brown net-like pattern on leaves, leaf sheaths and glumes with yellowing of the areas surrounding the net pattern.
- At initial stages it is having elongated lesions parallel to each other, which fuse together at later stages.





Loose smut: *Ustilago nuda*

The entire inflorescence gets turned to smutted head containing black powdery masses. The disease is caused by the internally seed borne pathogen and expresses only at the time of flowering. The losses in infected spikes are hundred per cent.

Covered Smut: *Ustilago hordei*

Masses of dark brown smut spores replace the entire head of plants and spores are contained in a membrane until plant maturity. When spores are dislodged by threshing they infect the seed. The hard spore balls of covered smut are very common in soils of untreated plots harvest.

Powdery mildew: *Erysiphe graminis* . f. sp. *hordei*

Loose smut of Barley

Covered smut of Barley



Barley yellow dwarf virus



IDM for Barley

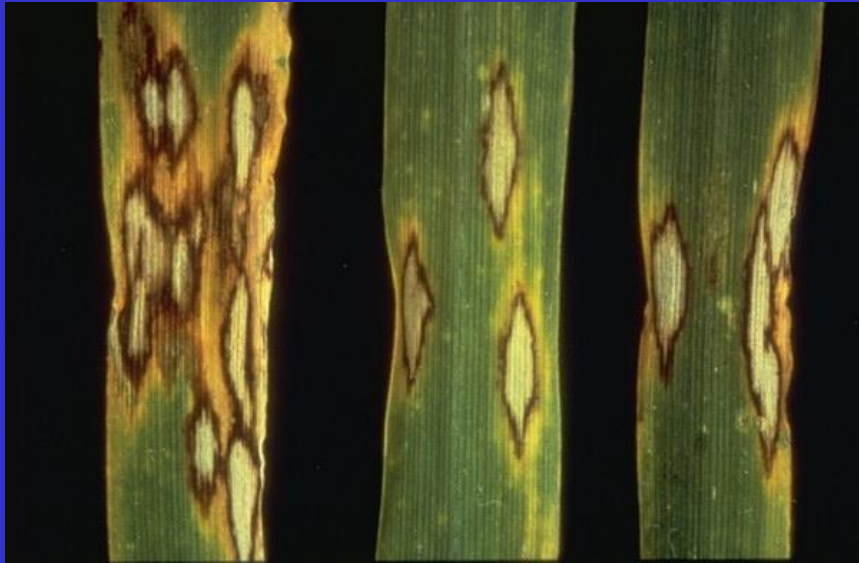
- **Seed treatment with Vitavax/Thiram Power @ 2-3g/kg or Tebuconazole 1g/kg of seed at time of sowing.**
- **Foliar sprays of Propiconazole (25 EC) @ 0.1% (200 ml in 200 litres of water/acre) at the appearance of rusts and foliar blights and later at 15 days intervals till physiological maturity, if needed.**
- **Crop rotation with non-host crops and removal of crop debris is also helpful in combating from the barley diseases.**

Loose smut of Oats



Barley leaf blotch or leaf scald

Septoria blotch on oats, caused by the fungus *Septoria avenae* f.sp. *avenae* (perfect state *Phaeosphaeria* [*Leptosphaeria*] *avenaria* f.sp. *avenaria* O.E. Erikss)



Rhynchosporium secalis



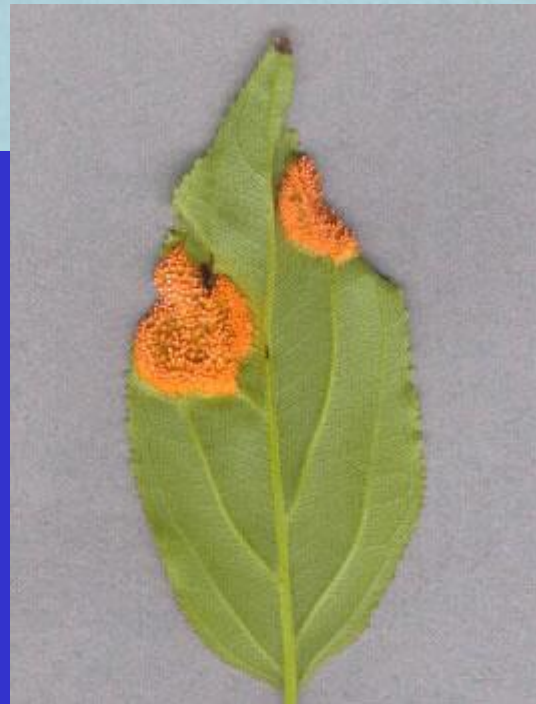
Oat crown rust, *Puccinia coronata*



Oat crown rust, *Puccinia coronata*



Oat crown rust, *Puccinia coronata*



Rye Rust - *Puccinia recondita* f.sp. *secalis*



Rye Ergot - *Claviceps purpurea*

