

Lect. 1

FIELD CROP DISEASES

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Field Crop Diseases

- Field crop (wheat, barley, rice, corn, pea, bean,....)
- Field crops are a daily food and the key source of nutrition for million's of poor people's a round the world.

average of total losses yearly;

- 14 % are caused by diseases
- 10 % by insects
- and 12 % by weeds.
- Considering that 14 % of the crops are lost to plant diseases alone, the total annual worldwide crop loss from plant diseases is about \$220 billion.
- To these should be added 6–12% losses of crops after harvest.
- Besides these losses do not include losses caused by environmental factors such as freezes, droughts, air pollutants, nutrient deficiencies, and toxicities.

What is the first step in successful disease control?

Recognition of the disease, and understanding of the pathogen(s) responsible, is the first step in successful disease control.

Cereal Diseases

Rusts and smuts are important cereal diseases which occur worldwide.

RUSTS

Historical Perspectives:

The occurrence of rust diseases in cultivated cereals has significantly influenced the development of human civilisation.

- Biblical accounts, at about 1870 BC, indicate that rust epidemics forced the family of patriarch Jacob to seek refuge in Egypt.
- And the rust was recorded in the early Greek and Roman literatures where, in about 500 BC, ceremonial details indicate liturgies (religious ceremony) to appease Robigus, the Corn God, in an attempt to prevent crop failure.



Rusts

- A problem since the first cereal crops were grown.
- Are obligate parasites that require a living host to complete the life cycle
- Widely disseminated over wide geographic areas by wind borne spores.
- Are well suited to incite serious epidemics because they can produce large numbers of infectious spores (urediniospores).
- Different from most fungi, the rust variations have five spore stages and alternate between two hosts.

-	<i>On primary host (wheat)</i>	<i>On alternate host</i>
	1. <i>Urediniospores</i>	4. <i>Pycniospores</i>
	2. <i>Teliospores</i>	5. <i>Aeciospores</i>
	3. <i>Basidiospores</i>	

Stem rust of wheat

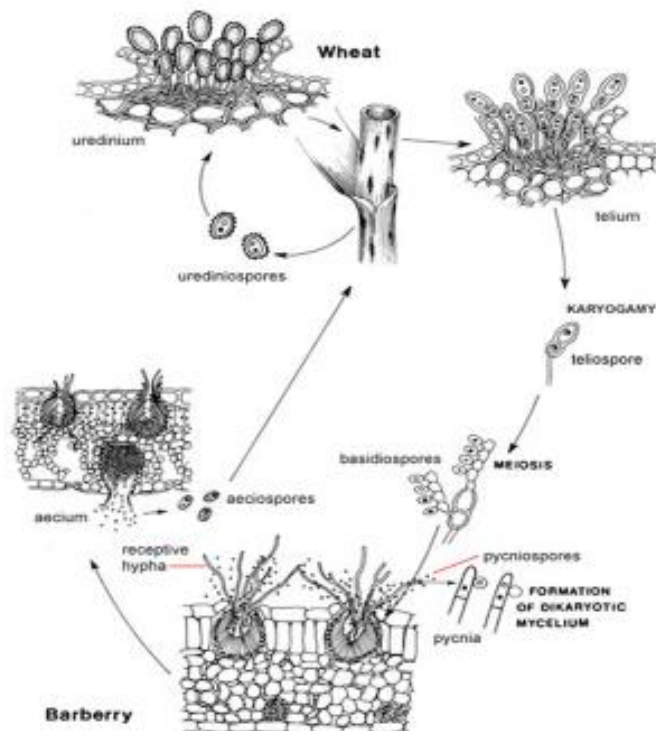
DISEASE: Stem (black) rust (*Puccinia graminis*)

HOSTS: Wheat, barley and barberry

PATHOGEN: *Puccinia graminis* f. sp. *Tritici*
(specific to wheat)



Life cycle of
a heteroecious,
macrocyclic cereal rust.
(*Puccinia graminis*)



Symptoms and Signs On wheat



The characteristic rust color on stems and leaves is typical of a general stem rust.

SYMPTOMS:

- Plants show symptoms 7 to 15 days after infection.
- Presence of brick-red uredinia on the plant (appear as oval lesions on leaf sheaths, stem, and spike), sporulate on both surfaces of the leaves (*urediniospores*).
- There can be multiple generations of inoculum produced during a single growing season.
- One uredinium can produce at least 100,000 *urediniospores*.



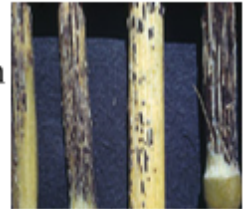
SYMPTOMS:

Teliospores: Toward the end of the growing season, black overwintering teliospores are formed in pustules (telia). For this reason stem rust is also known as 'black rust'.

The telia are firmly attached to the plant tissue.

This spore stage is an important source of genetic recombination in addition to its role as a survival spore

Teliospores (the survival stage)
in pustules on wheat.



Microscopically, teliospores of *Puccinia graminis* f. sp. *tritici* are two celled and thick walled.



- In the spring, each teliospore germinates to produce thin-walled, colorless basidiospores. Basidiospores infect the alternate hosts such as common barberry.
- Basidiospores germinate and produce mycelium which colonizes the leaf tissue.

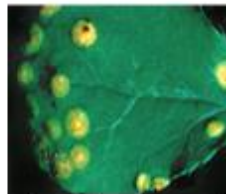
Basidiospores



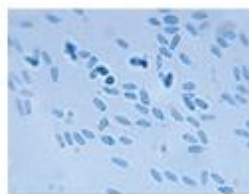
SYMPTOMS:

On barberry and other alternate hosts:

Common barberry (*Berberis vulgaris*), the alternate host of *Puccinia graminis*.

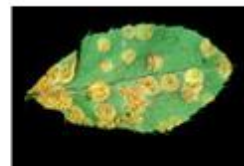


Pycnia on barberry leaf.



Pycniospores

Aeciospores on barberry leaf. These spores infect wheat.



Pycniospores



Aeciospores

Stem rust

Importance:

- Is a significant disease affecting cereal crops.
- It is estimated that more than \$5 billion are lost to cereal rusts (leaf rust, stem rust, and stripe rust) each year.
- Infected plants produce fewer tillers and set fewer seed, and in cases of severe infection the plant may die.

DISTRIBUTION:

Occurs worldwide wherever wheat is grown.

YIELD LOSS:

- Losses are often severe (50 to 70%).
- Damage is greatest when the disease becomes severe before the grain is completely formed.
- Grains are shriveled due to the damage to the conducting tissue, resulting in fewer nutrients being transported to the grain.
- Severe disease can cause straw breakage, resulting in a loss of spikes with combine harvesting.



INOCULUM SOURCE AND INFECTION:

In warm climates, wheat is planted in late fall and harvested in early summer.

- Mycelium or uredinia on volunteer wheat are the most important source of inoculum.
- *Urediniospores* are the first spores to infect the young wheat plants.
- Seed spilled in the field at harvest time often sprout and produce volunteer plants.
- These plants can become infected from spores produced on late-maturing wheat plants still in the field.
- infected volunteer wheat plants serve as a bridge that carries *P. graminis* through the summer to the next fall-sown crop of wheat.

Control:

- 1- Eradication of barberry, other weeds and volunteer wheat
- 2- Use of wheat resistant varieties
- 3- Spray fungicides
- 4- Seed treatments with systemic fungicides

Disease name: Leaf (brown) rust of wheat

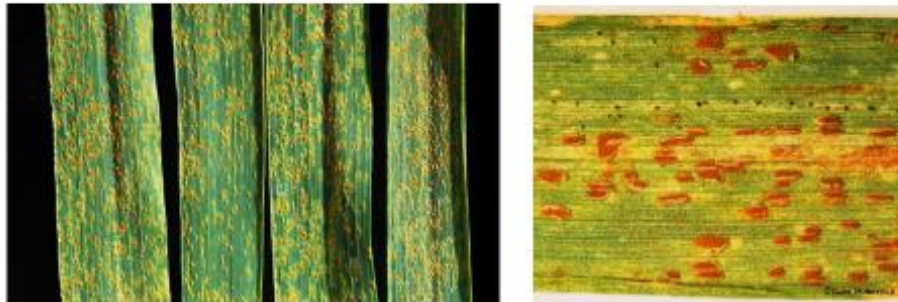
Wheat leaf rust, caused by the fungus *Puccinia triticina*
(formerly *P. recondita* f. sp. tritici).

Leaf rust is very important in wheat growing areas of the world.

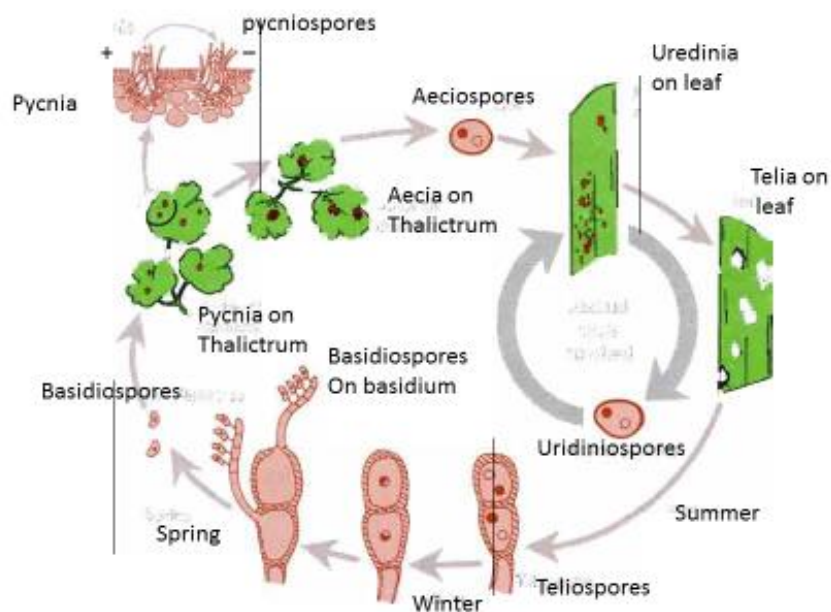


Symptoms and signs

Symptoms of brown rust infection are often seen in the autumn on early-sown crops as individual orange to brown pustules.



The most characteristic signs of leaf rust infection are the rusty-red spores (Uredinia) in round to oval pustules breaking through the leaf surface.



Life and disease cycles for *Puccinia recondita* f.sp. *tritici* (wheat leaf rust).

Importance:

- Is the most common rust disease of wheat on a worldwide basis.
- Losses of between 5 and 20% are normal but may reach 50% in severe cases.
- The fungus is an obligate parasite capable of producing infectious urediniospores as long as infected leaf tissue remains alive.
- Urediniospores can be wind-disseminated and infect host plants hundreds of kilometers from their source plant, which can result in wheat leaf rust epidemics on a continental scale when environmental conditions are favorable.

The following factors must be present for wheat leaf rust infection to occur:

- Viable spores.
- Susceptible or moderately susceptible wheat plants.
- Moisture on the leaves (six to eight hours of dew) and favorable temperatures (15 – 20 C).
- Relatively cool nights combined with warm days are optimum conditions for leaf rust development.
- Under favorable environmental conditions, rust spores germinate and penetrate into the leaf.
- After around 10 – 14 days of infection, the fungus will begin to sporulate and the symptoms will become visible on the wheat leaves.

Control

- Resistant varieties.
- Foliar fungicides.
- seed treatments.
- Control of volunteer wheat.
- Removing the alternate host.

Stripe Rust (Yellow Rust)

Puccinia striiformis (synonym *P. glumarum*)

Hosts:

Wheat , barley and some perennial grasses may also become infected.



BF 2099 [RM] © www.visualphotos.com

The infection is characterized by a yellow-orange spore that forms in parallel lines on the leaf surface.

Symptoms:

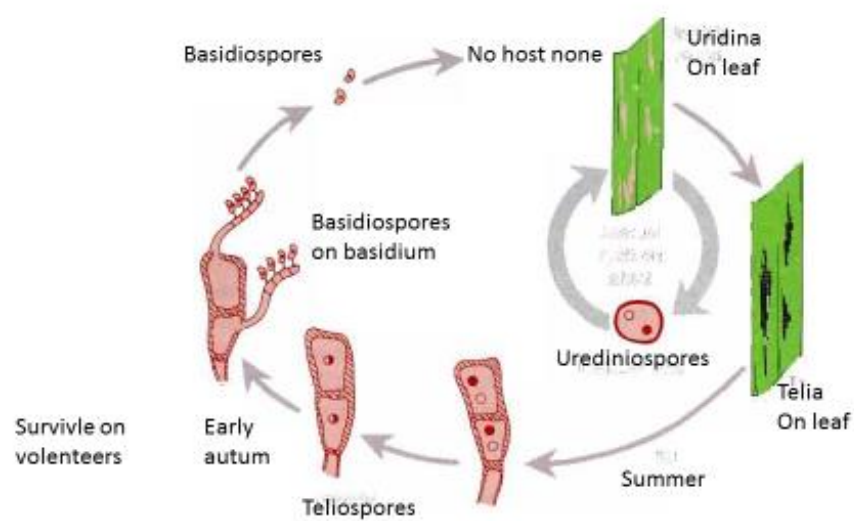
- Symptoms usually appear earlier in the season than other rusts because the fungus develops at lower temperatures than the other rust fungi (6-12°C).
- Cool, wet conditions favor this rust.
- As the plants mature, the pustules turn dark and shiny when teliospores are formed.



Unlike other rust species, stripe rust produces lesions along the axis of the leaf it infects.



When scouting fields, stripe rust often appear as yellow off-colored foliage from a distance.



Life and disease cycles for *Puccinia striiformis* (wheat stripe rust).

Importance:

- Can cause significant loss to wheat yield and grain quality, given appropriate environmental conditions and susceptible varieties.
- Can also infect the developing head reducing grain number and size.
- The fungus is dispersed as wind-blown spores which produce new infections. This cycle is repeated many times during the cropping season causing epidemics to develop.

Environmental Conditions:

- The fungus requires temperatures of less than 18°C (optimum 6- 12°C) with a minimum of three hours of leaf-wetness (for example, dew) for new infections to occur.
- Once an infection is established the fungus can survive short periods of temperatures as high as 40°C.
- Survives the summer on volunteer or self-sown wheat plants to allow a new epidemic to develop in the following season

Control:

- Remove volunteer wheat plants .
- Use resistant varieties.
- Use a seed or fertilizer treatment.
- apply a foliar fungicide

- Stripe **rust** can only survive from one season to the next on living plants, therefore removing volunteer wheat plants that will support stripe rust inoculum in the 6 weeks prior to sowing.
- Avoid susceptible varieties by selecting more resistant varieties.
- Use a seed or fertilizer treatment to suppress early infection.
- Effective fungicides for controlling stripe rust are available.
- Monitor crops during the growing season and apply a foliar fungicide early in the epidemic, if required.

SYMPTOMS AND SPORE MORPHOLOGY OF THE RUST DISEASES



Uredinia

Urediniospores (400x)

STEM RUST



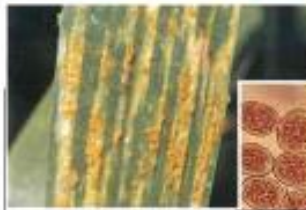
Telia



Teliospores (400x)



LEAF RUST



STRIPE RUST



T.Amin