

THE RUSTS

OCCURRENCE AND IMPORTANCE:

The rust diseases are very common and conspicuous on account of the bright orange to rusty brown, powdery masses of spores erupting from the host tissue. They are, evidently, the most important diseases of cereals and grasses and cause serious economic losses. A loss of about 10 percent on the total world production of wheat has been estimated.

The rust fungi are obligate parasites and comprise a single order uredinales, which has three families Pucciniaceae, Melampsoraceae and coleosporiaceae and 130 genera and 3000 species.

TYPES OF RUST ON THE BASIS OF NUMBER OF HOST REQUIRED

1. **Autoecious rust:** Most rust organisms complete their life cycles on one host and are termed autoecious
2. **Heteroecious rust:** Those that require two unrelated host species for completion of their life cycles and they are heteroecious. This phenomenon is unique to the rusts.

TYPES OF RUST ON THE BASIS OF LIFE CYCLE

Rust fungi can be categorized by how many types of spores are produced during the life cycle.

1. **Macrocytic rust:** Fungi that produce all five spores (sometimes excluding pycniospores) are termed macrocytic rust.
2. **Microcytic rust:** Fungi that lack pycniospores and aeciospores in their life cycle are termed microcytic rust and always have an autoecious life cycle.
3. **Demicytic rust:** Fungi delete the uredial (repeating) stage from the life cycle. Understanding the life cycles of rust fungi allows for proper disease management.

SPORE STAGE OF RUST FUNGI

They are polymorphic and as many as five spore forms may be produced, which if present always occur in the following sequence:

Rusts can produce up to five spore types during their life cycle

- 0-Pycniospores (Spermatia)-Haploid gametes in heterothallic rusts.

- I-**Aeciospores**-non-repeating dikaryotic vegetative spores
- II-**Urediniospores**-repeating dikaryotic vegetative spores. These spores are referred to as the repeating stage because they can cause auto-infection (re-infect the same host from which the spores were borne). These spores are red/orange and are a characteristic sign of rust fungus infection.
- III-**Teliospores**-Diploid spores that produce basidia and are the survival stage of life cycle
- IV-**Basidiospores**-stem from basidia. Haploid spores which infect the alternate host. Although these are rarely observed outside of the laboratory.

INFECTION PROCESS

The fungi produce asexual spores which disperse by wind, water or by insect vectors spreading the infection. Rust fungi are biotrophs taking nutrients from living cells.

Air borne spores settle on plant_____weak hydrophobic interaction formed with cutin (Securing plant cell)_____Adhesins (Mucous like substances, initially stick the spores to plant surface)_____Spore germinate_____produce germ tube_____Locates stomata_____Thigmotropism (Touch responsive process) (Thigmotropism is a directional growth movement which occurs as a mechanosensory response to a touch stimulus)._____Perpendicular growth which ends at stomata_____Inside stoma appressoria produced (It is thought that the whole process is mediated by a mechano-sensitive calcium ion channel, located within the germ tube tip, which produces electric currents that stretch the cell membranes, changing gene expression and forming the appresorium.)_____ Infection peg grows into plant mesophyll cells_____Haustoria_____ The plant cell membranes invaginate around the main haustorial body forming a space known as the extra-haustorial matrix. An iron and phosphorus rich neck band bridges the plant and fungal membranes in the space between the cells for water flow, known as the apoplast, thus preventing the nutrients reaching the plant's cells. The haustorium contains amino acid and hexose sugar transporters and H^+ -ATPases which are used for active transport of nutrients from the plant nourishing the fungus. It continues growing until spore growth occurs. The process repeats every 10 – 14 days, producing numerous spores, carried by wind to new hosts.

SPORE DISPERSAL

Puccinia graminis produces all five of the spore types that are known for rust fungi. Spores are typically deposited close to the source, but long-distance dispersal is also well documented. The following three categories of long-distance dispersal are known to occur:

1. EXTREMELY LONG-DISTANCE DISPERSAL

This can occur unassisted (the robust nature of the spores allows them to be carried long distances in the air and then deposited by rain-scrubbing) or assisted (typically on human clothing or infected plant material that is transported between regions). This type of dispersal is rare and is very difficult to predict.

2. STEP-WISE RANGE EXPANSION

This is probably the most common mode of long-distance dispersal and usually occurs within a country or region.

3. EXTINCTION AND RECOLONIZATION

This occurs in areas that have unsuitable conditions for year-round survival of *Puccinia graminis* - typically temperate regions where hosts are absent during either the winter or summer. Spores overwinter or over summer in another region and then recolonise when conditions are favourable.