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Paper: **I**
Topic: **Fungi – Puccinia**
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Habit and Habitat of Puccinia Graminis:

P. graminis is an obligate parasite, polymorphic, macro cyclic and heteroecious rust. It affects wide range of hosts including wheat, barley, oats and rye. *P. graminis tritici* involves in its life cycle two distinct alternate host plants i.e., wheat (*Triticum vulgare*) and Barberry (*Berberis vulgaris*).

The wheat plant is called the primary host and the barberry plant is secondary or alternate host. In Northern India the black rust appears after March, but in South India, the rust may appear as early as in the fourth week of November thus, causing great loss to wheat crops.

Symptoms of *Puccinia Graminis*:

On Wheat:

The symptoms of the disease appear as large, elongated and brown pustules (uredosori) on the stem, leaf, sheath and leaf. Later on these brown pustules change into black coloured large pustules (teleutosori). Grains of the infected plants are shriveled, much lighter in weight and thus reducing the yield.

The pathogen shows a balanced host parasitic relationship. Even in the severe infection, the parasite does not cause much serious damage except that the growth of the plants may be somewhat retarded and the grains may be of reduced size and of poor quality.

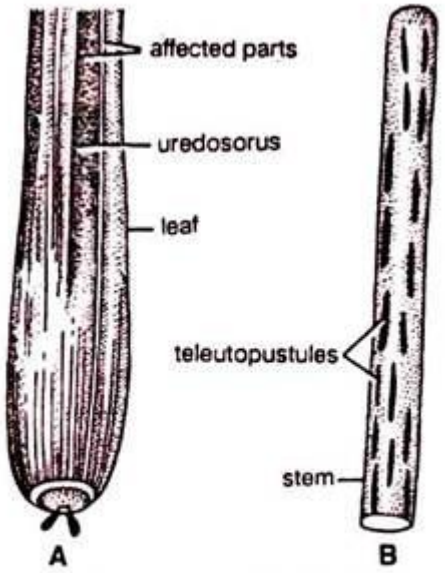

Fig. 1 (A, B). *Puccinia gaminis* tritici: Symptoms on wheat plant. (A) Uredosorus on leaf; (B) Teleutopustules on stem

On Barberry:

Infection first starts on the dorsal surface of the leaf in the form of minute, dark coloured and flask shaped pycnia which appear as yellow spots. Beneath Pycnia, on the ventral surface, appears cup like projections of aecia or aecidia.

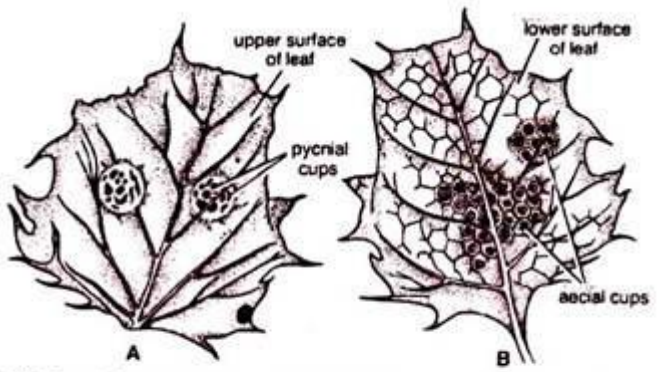

Fig. 2. (A, B) *Puccinia* graminis *tritici* : Symptoms on barberry plant. (A) Dorsal surface of leaf showing the pycnial cups, (B) Ventral surface of the leaf showing the aecial cups

Vegetative Structure of Puccinia Graminis:

The mycelium is dikaryotic (each cell of the mycelium bears two nuclei) on primary host (wheat) and monokaryotic (each cell of the mycelium bears only one nucleus) on the secondary or alternate host (barbery). The monocaryotic mycelium is also called hapiomycelium or primary hyphae and the dikaryotic mycelium is called secondary hyphae.

The mycelium is well developed, branched, septate and does not spread throughout the host, but is localized to isolated patches. It is either intercellular or intracellular, with the former producing bulbous, branched or knotted haustoria into the cells for obtaining nourishment.

The transverse septa are present or long intervals between the cells. Each septum contains a simple central pore. Cell wall is made up of fungal cellulose. The cytoplasmic membrane surrounds the granular cytoplasm and reserve food material remains in the form of glycogen bodies and oil globules.

4. Life Cycle of *Puccinia Graminis:*

Puccinia graminis is long cycled rust (macro cyclic). At the time of reproduction it produces five distinct stages in a regular sequence.

These are as follows:

Out of these five stages, Uredo stage, Teleuto stage are produced on the primary host (wheat) and remaining two stages, (spermogonial and aecial stages) are produced on the secondary host i.e., barberry.

Stages on Primary Host (Wheat):

Uredospore's or Uredo stage:

This stage is formed by the infection of the aeciospores brought from the infected barberry plants or by the uredospores themselves coming from the neighboring wheat plants infected earlier. Both the spores are bi-nucleate and on germination, produce a germ tube on wheat leaf.

The germ tube grows over the surface of the epidermis of the host and on reaching a stoma its tip swells up and forms a vesicle like structure called appressorium. The protoplasm of the germ tube migrates into the appressorium. Now it is cut off from the germ tube by a septum. The appressorium produces a narrow hypha. It enters inside the sub-stomatal chamber through stoma.

Its tip again swells up and forms a sub-stomatal vesicle. The contents of the appressorium migrate to vesicle through narrow hypha. A hypha of the dikaryon (two nuclei) cells develops from this vesicle. It branches and produces hyphae which spread in between the cell (intercellular) but occasionally produce hausotria.

Development of Uredospore:

Within 5-6 days, the mycelium absorbs sufficient food from the host. It begins to aggregate near the surface of the infected organs and forms a compact mass. These are called uredia. From these uredia arise vertically a layer of bi-nucleate parallel cells known as basal cells. The basal cells elongate vertically and divide transversely into a lower cell (foot cell) and an upper cell (uredospore mother cell).

The upper cell divides again and its upper daughter cell swells to form a single, bi-nucleate, oval, uredospore or uredinospore, while the lower daughter cell matures into a stalk. Thus, the uredospores are formed in a group and each such group is called as uredospores or uredinium. The developing uredospores exert pressure on the over-lying epidermis. By this pressure the epidermis bulges out and later breaks up and the uredospores get exposed.

The uredospores are golden brown and oblong, ovate or ellipsoidal in shape. They are double walled, echinulate, binucleate (the two nuclei belonging to opposite strains) and possess four equatorially arranged germ pores.

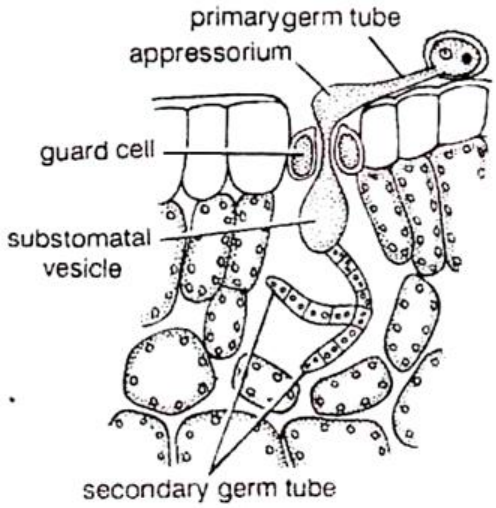

Fig. 3. *Puccinia* : Germination of uredospore on wheat leaf. Note the formation of appressorium

A uredospore can infect only a wheat plant. After falling on a suitable host it germinates within a few hours and produces a dikaryotic mycelium. The mycelium is capable of producing uredospores again within 10-12 days after germination. Thus, these spores cause several successive infections during the season, and spread the fungus and the disease from field to field provided the environmental conditions are favorable (sufficient moisture). On the basis of the aforesaid behavior these uredospores are also known as repeating spores.

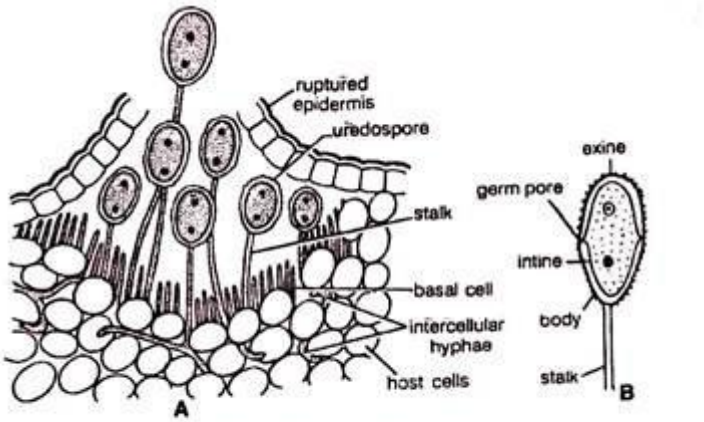

Fig. 4 (A–B). *Puccinia graminis* : T.S. wheat leaf passing through a uredosorus, (B) A uredospore

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