# *PUCCINIA*: GENERAL CHARACTERS, CLASSIFICATION AND LIFE CYCLE

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## Systematic Position of *Puccinia*

| | | |
|---|---|---|
| Kingdom | - | Mycota |
| Division | - | Eumycota |
| Sub-division | - | Basidiomycotina |
| Class | - | Teliomycetes |
| Order | - | Uredinales |
| Family | - | Pucciniaceae |

- *Puccinia* is a very large genus with about 1800 species, distributed in all parts of the world
- The genus is represented by more than 147 species, which cause serious rust disease in cereal crops like wheat, barley, oats and maize.
- The species of Puccinia are internal obligate parasites; only spore are seen on the host surface.

- Species of *Puccinia* are either autoecious (complete life cycle on single host) or heteroecious ( they complete life cycle on two different host).
- In India wheat crop is infected by the following three species of *Puccinia* which cause considerable damage to the crop.

1. *Puccinia graminis* - Black rust or stem rust
2. *Puccinia recondita* - Brown rust or leaf rust
3. *Puccinia striigormis* - Yellow rust or stripe rust

## *Puccinia graminis*

- *Puccinia graminis* is the casual organism for black rust disease of wheat and other cereal crops
- This disease is also known as stem rust .
- *P . graminis* is an obligate parasite

- It is heteroecious fungus.
- There are two phases in its life cycle – dikaryophase and haplophase.
- Dikaryophase occurs in its primary host that is wheat plant ( *Triticum aestivum*), whereas the haplophase in its alternate host that is *Berberis vulgaris.*

✓ Although *P. graminis* can survive in the absense of alternate host but its life cycle completed only when both hosts are avilable.

**Physiological specialization:**

- *P. graminis* has several physiological races , which show physiological specificity twoards their host.
- *P. graminis* cause rust disease in several cereal crops like wheat barley or oats but the strain which infects wheat plant does not infects barley or oats.

## Vegetative structure

There are two types of mycelia

1. Dikaryotic mycelium: Occurs in primary host (wheat plant) .
2. Monokaryotic mycelium : occur in the alternate host ( Barberry bushes).

- Both these mycelia are intercellular, septate and branched
- There is simple pore in each septum, which maintains protoplasmic connections between the adjecent cells.
- Each cell of the dikaryotic mycelium have two nucleus and monokaryotic mycelium have single nucleus.
- The mycelium takes nourishment from the host cells with the help of spherical haustoria.

# Life cycle

*Puccinia graminis* is a macrocyclic heteroecious rust.

There are five types of spore in its life cycle

1. Uredospores
2. Teleutospores
3. Basidiospores
4. Pycnidiospores
5. Aeciospores

➢ These spores develop in two different hosts in a definite sequence. The sequence of various stages occurring in the primary and alternate hosts are as follows

| | |
|---|---|
| Uredospores<br>Teleutospores | On primary host (*Triticum aestivum*) |
| Basidiospores | |
| Pycnidiospores<br>Aeciospores | On alternate host (*Berberis vulgaris*) |

## Stages of *Puccinia graminis* on wheat plant

### 1. Uredospore stage

➢ The dikaryotic mycelium is produced by aeciospores on germination on wheat plants

➢ A binucleate uredospore develop at the tip of each erect hypha (Fig:…). These spores develop in groups and these groups are known as uredosori.

➢With the formation of uredospores disease symptom appears in form of reddish brown pustules or streaks on the stem, leaf and leaf base.

➢ These symptom usually appears in late spring. The host epidermis burst due to pressure of developing uredosori and thus uredospores get exposed and are liberated.

➢ The mature uredospore is oval stalked and binucleate structure (Fig. 1. B).

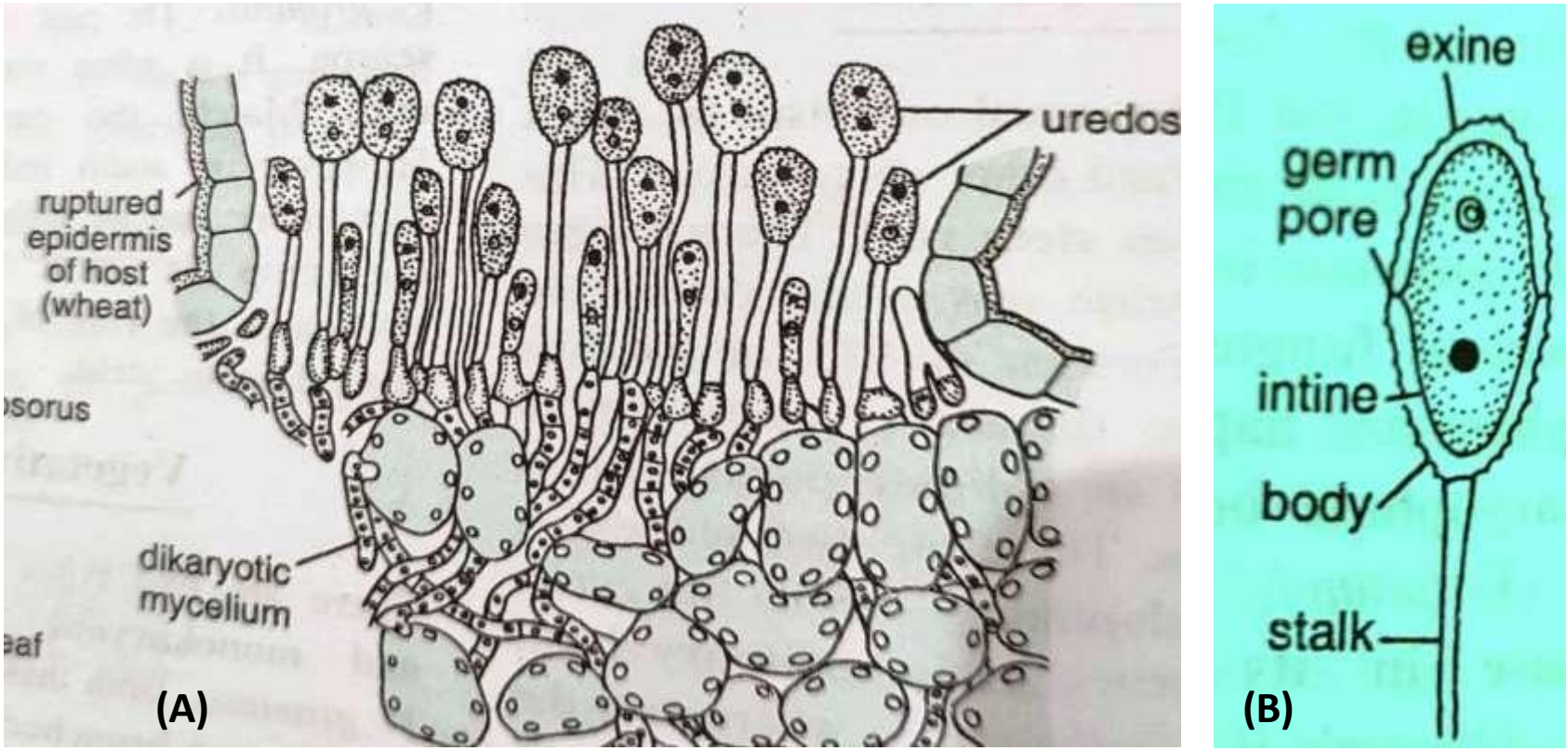



**Fig 1: (A)** Vertical section of wheat leaf passing through uredosorus , **(B)** A uredospore

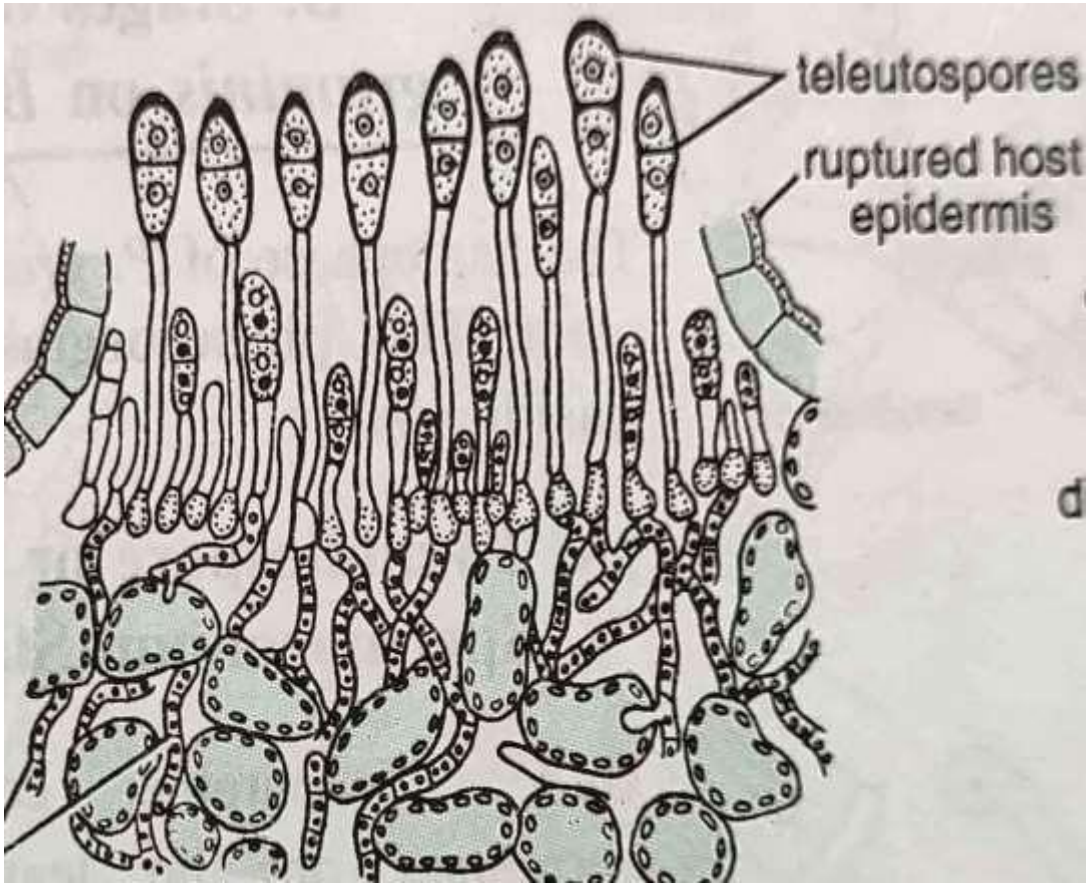
- The binucleate uredospore function as a conidium and it has capacity to germinate just after its formation.
- Uredosore can reinfect wheat plants and hence they are effective in the spread of the disease .
- Uredospore have not the capacity to infect the alternate host.

**Germination of Uredospore:**

- Under favorable conditions uredospores germinate as soon as they come in contact with fresh wheat leaves.
- The germ tube grows over the surface of host epidermis and on reaching a stoma the tip of the germ tube develop into the vesicle called appressorium.
- Hyphal branches develop from the appressorium into the intercellular spaces.
- This dikaryotic mycelium forms a new generation of uredospore which infect healthy plants.
- Once formed uredospore spread the disease rapidly under favorable condition

## 2. Telutospore stage

- At the end of the wheat season , uredosori also start to producing telutospore in addition to uredospore.
- The uredosori are ultimately converted into telutosori and produce telutospore exclusively.
- The telutospore is stalked, bi-celled, spindle shaped structure constricted slightly at the septum.
- The wall of the telutospore is thick and smooth and tip is usually pointed or round .
- Each cell of telutospore is binucleated and is provided with the germ pore.
- As the telutospore mature the two nuclei in a cell is fused to form a diploid nucleus.
- Telutospore act as resting spore and may survive most of the unfavorable conditions.
- Telutospore are not capable of reinfectining the wheat plant.
- Under favourable condition of high atmospheric humidity and low temprature they germinate in soil as no host is required for their germination.



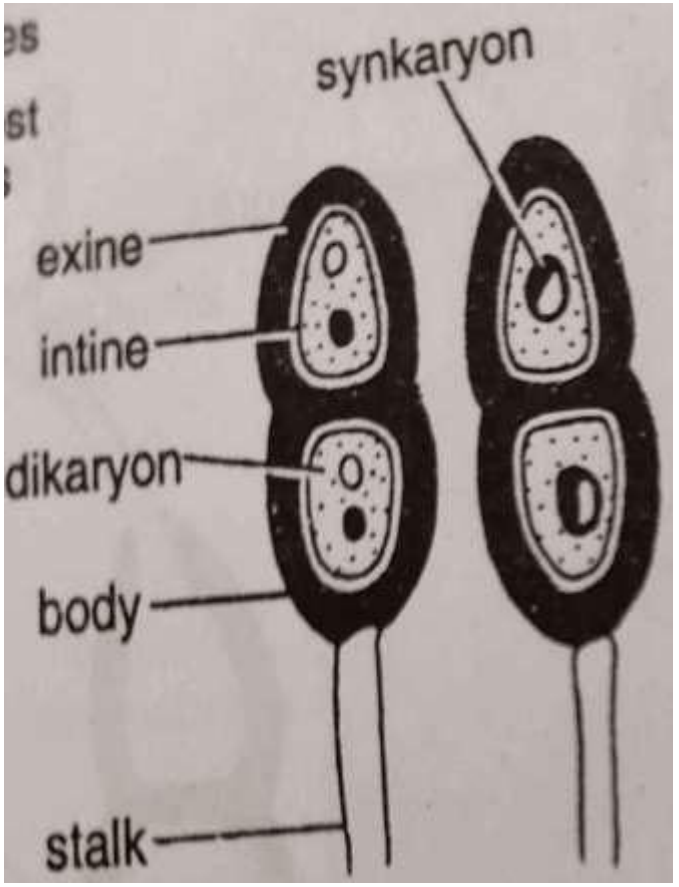




**Fig 2: (A)** Vertical section of wheat leaf passing through telutosorus , **(B)** A telutospore

## 3. Basidiospore stage

- On return of favorable conditions in spring the telutospore germinates. It produces one germ tube from each cell.
- The germ tube has limited growth and I known as promycelium or epibasidium.
- The diploid nucleus move into promycelium and divides meiotically to form four haploid nuclei (2 + and 2 -).
- The promycelium divides into four cells by the formation of transverse septa.
- Each cell produces a single basidiospore which is borne asymmetrically on a fine sterigmata.
- Basidiospores are small thin walled, unicellular structure with haploid nucleus.
- Basidiospores are discharged by explosive mechanism and are disseminated by wind.
- Basidiospores germinate only on the leaves of alternate host , the barberry bushes.
- Basidiospores can survive only for few days.

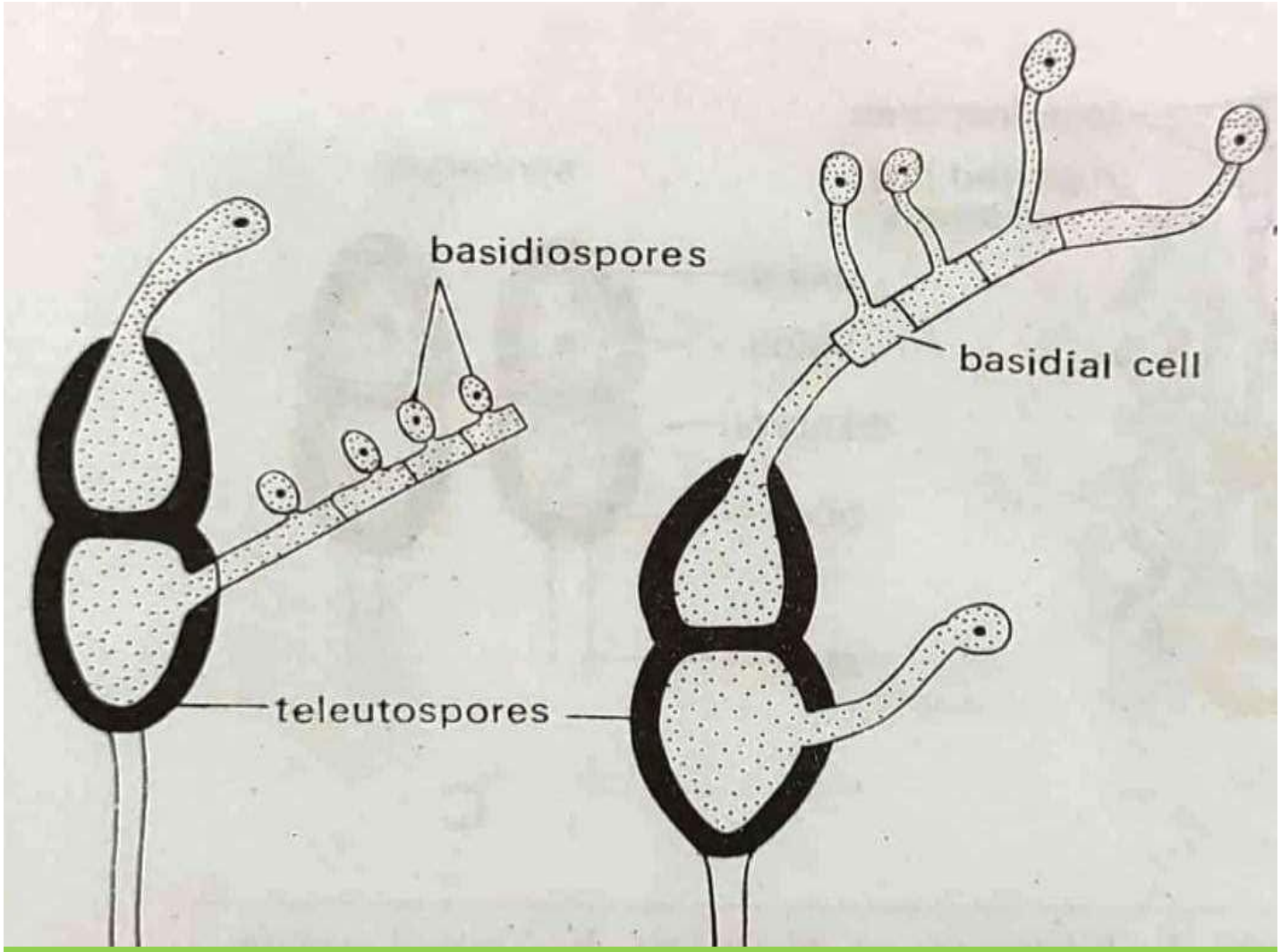



**Fig. 3: Germination of telutospore and formation of basidia**

## Stages of *Puccinia graminis* on *Berberis* plant

The haplophase of *Puccinia gramins* occurs on Berberis plant . This phase begins with the formation of basidiospores.

## 4. Pycnidiospore or spermogonium stage

- The basidiospores germinate on leaves of alternate host and thus form monokaryotic mycelium (+ and – strain ).
- The mycelium forms flask shaped spermogonia or pycnidia on upper surface of leaves.
- The wall of pycnidium is lined internally by spermatiophores or pycniophores each of which produces many small uninucleate spermatia or pycniospores or pycnidiospores.
- These may be + or – strain.
- The pycniospores neither infect primary host nor the alternate host.
- Inside the pycnidium there are also present flexous hyphae (receptive hyphae) and periphyses which came out through ostiole or pore of pycnidium.
- Now the pycniospores of one strain are transferred to flexous hyphae of opposite strain (spermatization) and a result of which dikaryotic mycelim is formed.

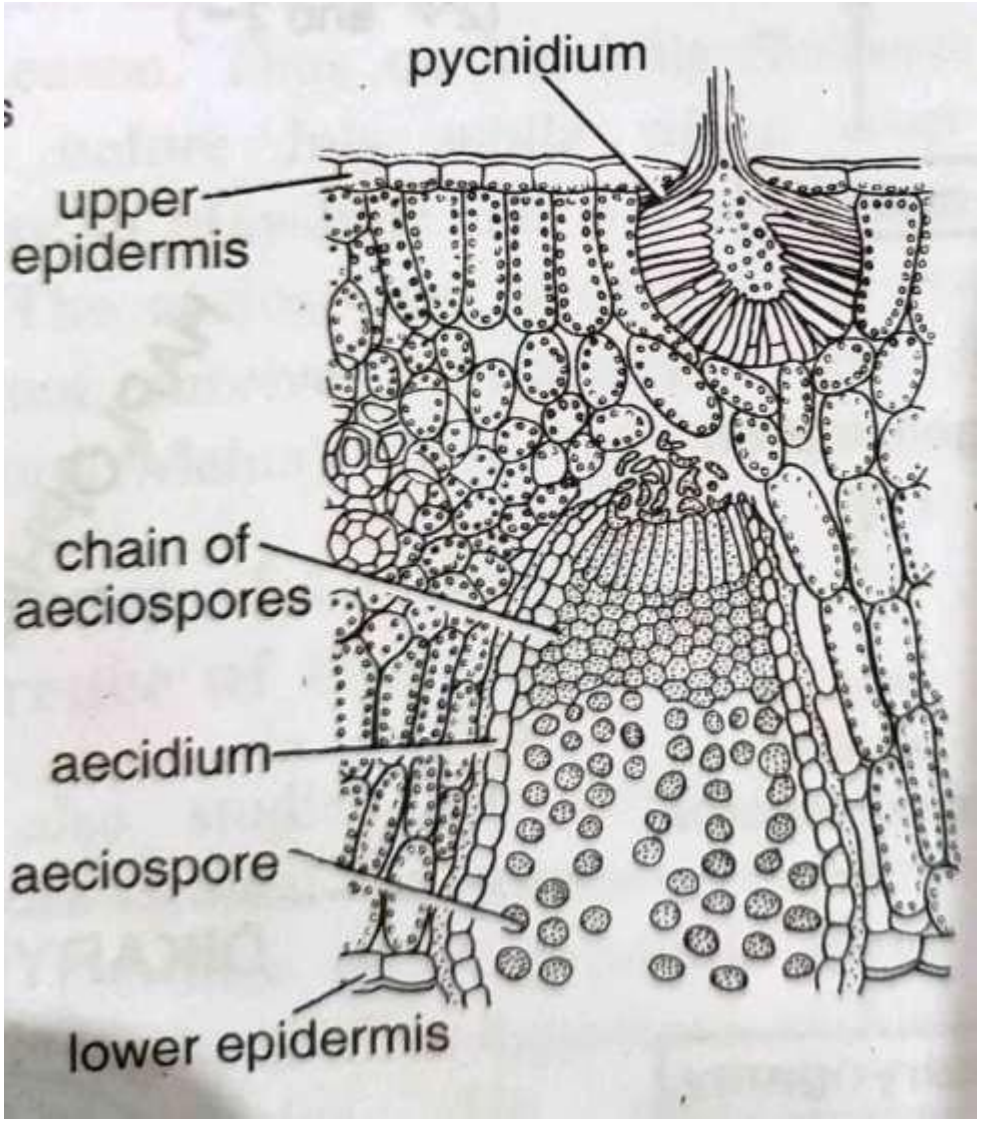



**Fig 4: Vertical section of leaf to show a young pycnidium (upper surface) and mature aecidium (lower surface)**

## 5. Aeciospore stage

- Aecidia are cup shaped structure formed on the lower surface of Barberry leaf.
- They develop from the same mycelium which forms pycnidia on the upper surface.
- Dikaryotic mycelium forms the roof of the protoaecidium.
- The cells of the protoaecidium are known as aecidiophores .
- Each aecidiophores cut off numerous binucleate cells which are arranged in chain.
- The chains are made up of long and short cells arranged alternately .
- The long cells mature into aeciospores, whereas short cells are known as disjunctor, remains sterile and soon disintigrate.
- Simultaneously with the formation of aeciospores , the peripheral cells of aecidium divide to form a thick protective covering known as peridium.
- Aeciospores are unicellular , thin walled binucleate structure.
- The aeciospores are incapable of infecting Barberry plants but they can infect wheat plant.
- They are dispersed by wind and germinate on the surface of primary host by producing germ tubes.

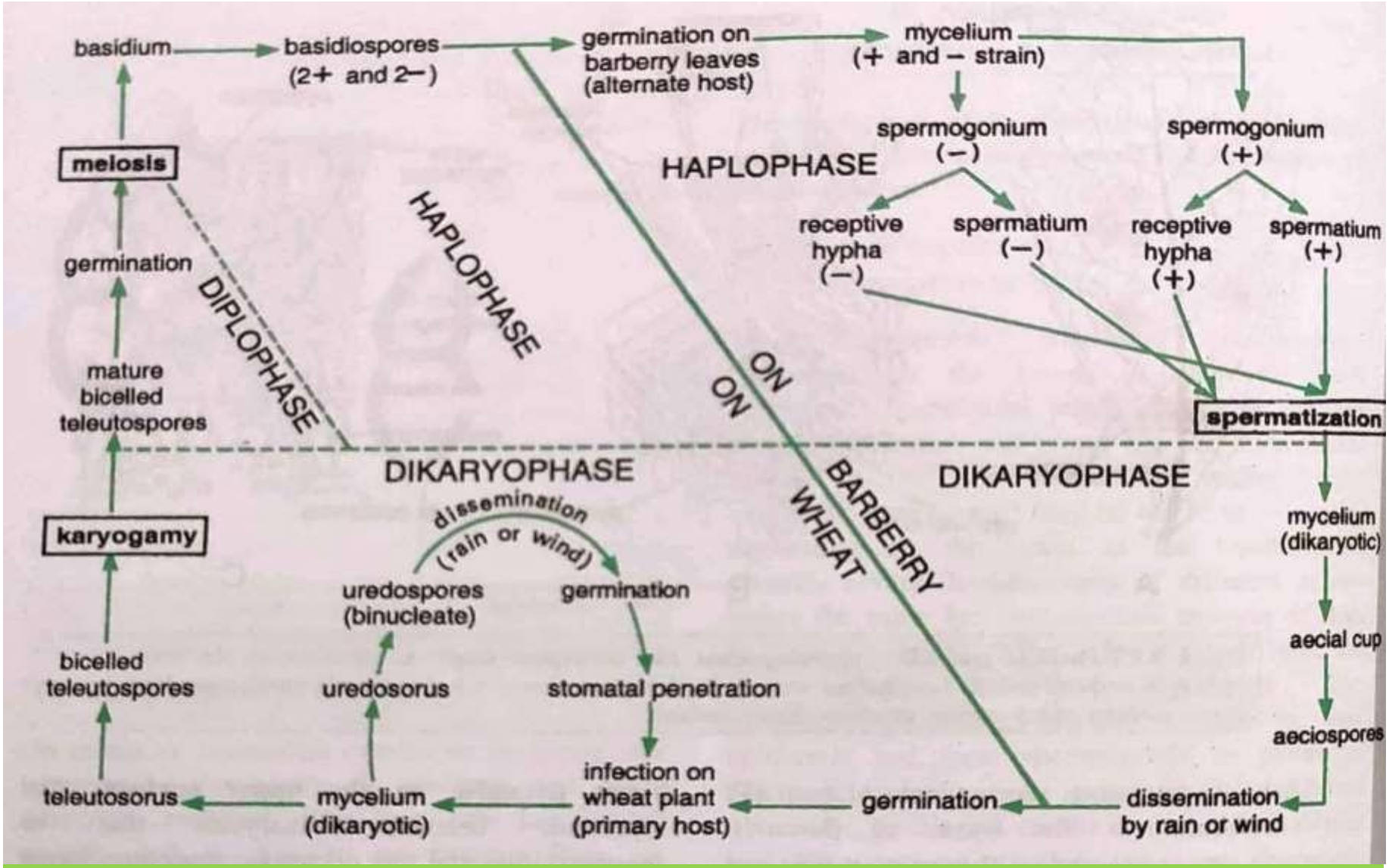



**Fig. 5: Schematic representation of the life cycle of *Puccinia graminis***

# Thank You !!