Black/Stem Rust Disease of Wheat

Pathogen: *Puccinia graminis tritici*

Systematic Position: Subdivision: Basidiomycotina; Class: Teliomycetes; Order: Uredinales; Family: Pucciniaceae

Distribution and Importance: The disease occurs in all the wheat growing countries of the world. In India, it appears at different times of the year in different parts of the country. It appears in the month of March in North India whereas in Southern India it appears very early in the fourth week of November. The disease is a serious threat to wheat cultivation in India. It causes serious damage in moist areas in wet seasons. Losses are quite high and annual loss was reported in 1960 being around 1 million tones worth about Rs. 4 crores at that time (Prasad, 1960).

Symptoms: The disease appears on two distinctly different host plants. The most serious and economically important symptoms are produced on wheat and another economically unimportant plant barberry and mahonia.

The symptoms on wheat plant appear first as long, narrow, elliptical blisters or pustules parallel with the long axis of the stem, leaf or leaf sheaths. Within a few days the epidermal covering of the pustules is ruptured exposing powdery mass of brick-red/brown coloured spores called *Uredospores*, the pustules called *Uredia/Uredosori*. They vary in size from very small to about 3 mm wide and 10 mm long. Later in the season, as the plant approaches maturity, the rusty colour of the pustules turns black as the fungus produces *Teliospores* instead of uredospores and uredia are transformed into *Telia/Telutosori* that are black in colour.

On Barberry, the symptoms appear as yellowish to orange coloured spots on the leaves generally on the upper side, appear a few minute dark coloured bodies called *Spermogonia/Pycnia* usually bearing a small droplet of liquid called *nectar*. On the lower side of the leaf beneath the spermogonia a group of orange-yellow cup-like projections called *Aecia* develop. These are another kind of sorus which contains orange coloured aeciospores in long or short chains.

Pathogen: *Puccinia graminis tritici* is a macrocyclic heteroecious rust fungus producing uredia and telia on wheat and other cereals and grasses. Other sori (spermogonia and aecia) are produced on barberry and mohonia. Each uredosorus (uredium) produces numerous short, erect stalks that bear uredospores. Each uredospore is an oval, brown in colour and single-celled with thick wall and echinulate structure. Each spore is capable causing a new infection and new pustules in suitable weather. The binucleate uredospores function as conidia and they are able to infect wheat plants only and not the alternate host barberry. The telutosori (telia) develop on the same mycelium, in the later part of the season. The teliospores are black or dark brown, stalked, two-celled with thick, smooth wall. The apex of teliospores is rounded or pointed. Each cell of the teliospore has two nuclei (one + type and the other - type). There is a single germ pore in the wall of each cell. During maturation period of teliospores, karyogamy takes place and the two nuclei in each cell of the teliospore fuse to form a diploid nucleus. Prior to germination, they undergo a period of rest of several months. Hence the teliospores are the resting spores. After the resting period, the teliospores germinate if the conditions are favourable. The conditions favourable for their germination are high humidity and freezing temperature for a longer time before germination (Ideally found in temperate countries like USA and Canada). In the plains of India, teliospores have lost their power of germination.

Basidial Stage: After the resting period and under favourable condition the teliospore germinates and produces basidia and the basidiospores. The basidiospores are small, unicellular, uninucleate haploid structure.

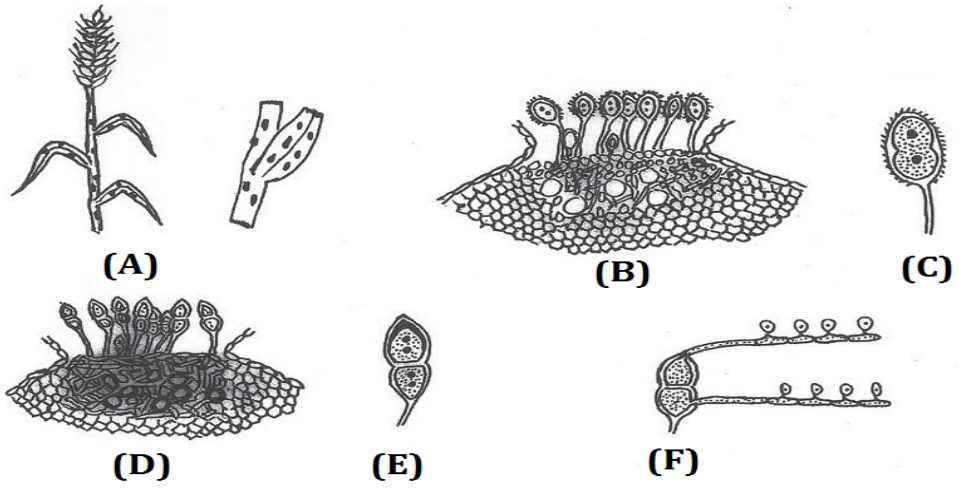
Disease Cycle: The black/stem rust of wheat is short cycle rust in India. The part of life cycle involving the alternate host barberry is cut out. It thus produces only uredospores and teliospores. The teliospores lose power of germination during summers and uredospores cannot withstand the high temperature of summer months in the plains.

There is thus no inoculum left in the fields to infect the next wheat crops. Then there arises the question that how does then the disease reoccur every year in the plains of India.(?). Till recently Mehta's hypothesis (1952, 1954) that the primary inoculum of black rust of wheat is introduced in the plains from the Himalayas in the North and from Nilgiri and Pulney hills in the South. According to Mehta's hypothesis at the higher altitudes (3000-7000 feet) the uredospores can oversummer in the congenial temperature on self-sown plants, out of season crops and possibly on grasses. The surviving uredospores serve as primary inoculum for the next wheat crop near or at the foothills. From there the infection spreads as the surviving uredospores are blown by wind from the infected plants in the foothills to the healthy wheat plants in the plains.

Recent investigations of Joshi *et al.* (1986) do not support Mehta's hypothesis. They argue that in the hills of Northern India low temperature conditions prevailing during November to February are unfavourable for sporulation, infection, establishment and spread of the disease. Rust pustules become inactive at lower temperatures (below 14 ^{0}C). When the conditions become favourable in the month of March, there is very little time left for its spread as the wheat plants reach maturity. In their view, the principal source of infection of black rust in the plains of North is the dissemination of inoculum from the South and Central India.

Disease Management:

1. **Cultural management:** Cultivation of ***early maturing varieties*** helps escape the disease. ***Early sowing*** of the crop can also be effective. ***Proper manuring*** and avoidance of excessive doses of Nitrogenous manures reduces the incidence of the disease. ***Proper irrigation*** to avoid high humidity is also important as high RH favours the disease. Light and controlled irrigation during January and February help in keeping the disease under economic threshold level.
2. **Resistant Varieties:** There are a number of resistant varieties recommended in the areas of prevalence of the disease. A short list is given below:
   (A) For Western Uttar Pradesh: Sangam, UP-2338, UP-2003, WH-542, Raj_3765, PBW-226, PBW-343.
   (B) For Eastern Uttar Pradesh: UP-262, K-8804, K-7410, HUW-206, Malviya-12.
   (C) For Bundelkhand Region: WH-147, HD-2327, Swati
3. **Chemical Fungicides:** Spraying of Indofil M-45 (mancozeb) @ 0.2% thrice at 10 days interval has been found to be most effective. Some recently developed fungicides like Contaf (hexaconazole) 1-2ml/litre of water and Captaf (captafol) 3g/litre of water are also effective to minimize the disease.



(A) Symptoms (teliopustules) on stem and leaves
(B) Uredospores/uredopustule in section of stem
(C) A single uredospore
(D) Teliopustule in section of stem
(E) A single teliospore
(F) Germination of a teliospore

YELLOW/STRIPE RUST OF WHEAT

Pathogen: *Puccinia striiformis/P. glumarum*

Distribution and Importance: This disease is widely distributed throughout the world wherever wheat crop is grown. In India, the disease is limited to northern and eastern India and rarely occurs in peninsular and western parts of the country. In comparison to other rusts of wheat, it appear earlier and therefore becomes more destructive. The disease is seen in mid-January and if there are heavy rains, it does much damage to the crop.

Symptoms: The uredia are chiefly formed on the leaf blades but when the attack is severe, they also appear on the leaf sheaths, stalks and glumes as well. The green colour of the leaves fades and long streaks are formed on which rows of small urodopustules appear. Each row consists of a series of oval, lemon-yellow pustules arranged end to end and each distinct from that above and below. Uredospores eventually break through the epidermis and yellow spore mass is exposed for wind dispersal. The telia appear later as dull-black patches in long, narrow lines like uredia. The telia are subepidermal and remain as flat, black crust. The telial patches appear on the undersurface of the leaves.

Pathogen: Like all other species of *Puccinia* this species is also characterized by presence of uredial, telial and other spore stages.

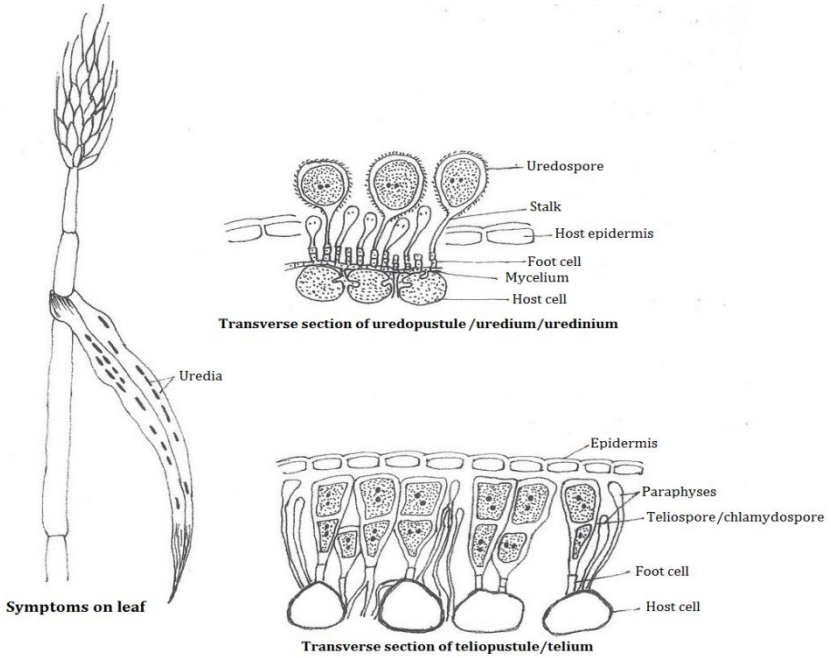
1. **Uredospores:** They are nearly round binucleate and unicellular. The spore-wall is colourless, minutely echinulate and may posses 6-16 germ pores per spore.
2. **Teliospores:** They are dark brown, bicelled, often flattened at the tip.

The disease is heteroecious but the altenate host is still uncertain. Therefore, the pycnial and aecial stages have not been observed in nature. Survival of the fungus is through uredospores formed on collateral hosts at high altitudes on the hills. The fungus also has many grass hosts including *Bromus japonicus*.

Disease cycle: The disease is airborne. The inoculum causing annual recurrence is brought from the hills to the plains every year. Uredospores oversummer on the high altitudes (at 7000 feet and above). The exact location of major source of inoculum of this rust is still not clearly known.

Disease Management:

1. Resistant varieties such as sangam, UP-2338, UP-2376, UP-1109, WH-542, WH-147, PBW-226, PBW-154, PBW-343, HP-1102, HD-2336, HD-2327, HD-2329, K-8804, K-7410, UP-1009 should be grown.
2. Chemical fungicides such as plantvax @ 0.1% a.i. or propiconazole (Tilt) 0.1% a.i. or captaf @ 3g/l of water should be sprayed when first symptoms appear and repeated at 15 days interval



BROWN/ORANGE/LEAF RUST OF WHEAT

Pathogen: *Puccinia recondita* (Syn. *P. triticina/P. rubigo-vera* var. *tritici*)

Distribution and importance: This rust is found throughout India, yet it is most common in the northern and eastern region. In Punjab, Bihar and Uttar Pradesh, this disease causes more damage than stem rust. In northern region, this disease appears earlier than other two (black and yellow) rusts. In U.P. the incidence of this rust takes place in the end of December or beginning of January along with yellow rust.

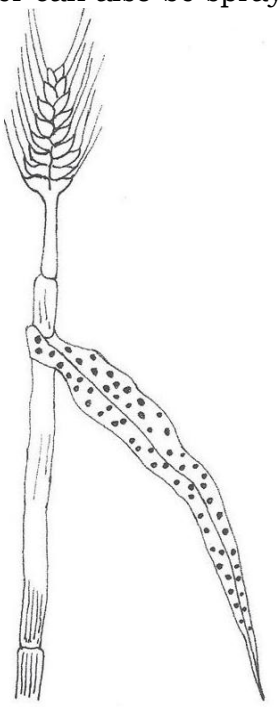
Symptoms: The uredia appear as a rule on the leaves and rare on the stems and leaf sheaths. The uredia are always scattered on the leaf surface, they are never in rows or stripes. The uredia burst out on the upper surface as point of a bright orange colour. The scattered uredia and their orange yellow colour form the most characteristic feature of the brown rust. Telia are rarely formed. When formed, they are similar to those of the yellow rust being on the undersurface of the leaves. They are small, oval or linear, dull black and subepidermal.

Pathogen: The uredospores are brown, spherical, minutely echinulate and bearing 7-10 germ pores. On germination, the germ tubes emerge through the germ pores which infect the wheat leaves through stomata. Telia are divided up into several compartments by partition of paraphyses. Teliospores are two-celled smooth, oblong, thick-walled and brown with rounded apex. The teliospores are slightly constricted at the septum. The brown rust is heteroecious; the aecial and pycnial stages of the fungus appear on species of *Thallictrum*. In India, the role of alternate hosts has not been precisely determined.

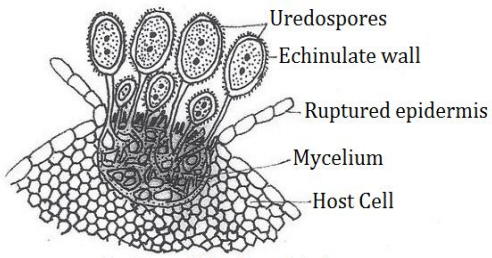
Disease cycle: The disease is airborne like other rusts of wheat. The inoculum (uredospores) survives on the tillers and self sown plant in the hills, the inoculum survives at 5000 ft and above. Every year the uredospores are carried over by wind from the hills to the plains where they cause infection.

Disease management:

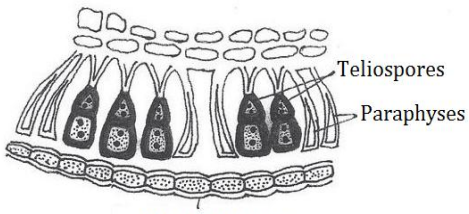
1. Resistant varieties such as sangam, UP-2338, Raj-3765, PBW-343, 373, WH-542, HUW-206, UP-262, 1109, HI-1077 must be grown in the areas of prevalence.
2. Chemicals such as Indofil-M-45 @ 0.2% must be sprayed thrice at 10 days interval. Tilt (Propiconazole) (0.1%) is also effective in reducing the disease incidence. Rh- 124 (Indar) is specific fungicide against brown rust of wheat. Contaf (hexaconazole) @ 1-2 ml/litre of water can also be sprayed as a control measure.



Symptoms (Brown uredopustules) on host leaf



Transverse Section of Uredopulstule



Transverse Section of Teliopustule