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The Ultimate Guide to Overcoming White Rusts or White Blisters (*Albugo candida*) in Mustard Crop

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White rust or white blisters disease is one of the common diseases of crucifer crops (Family – Brassicaceae). It is worldwide in distribution occurring in all the areas wherever crop is cultivated. Both wild and cultivated varieties are attacked. The disease affects a large number of crucifer crops of economic importance like Mustard, Cress, Rape, Radish, Cabbage, Cauliflower, turnip etc. In India the disease is reported on Mustard, Rape, *Eruca sativa*, turnip, Cauliflower and *Cleome viscosa*. White rusts or white blisters are the characteristic pustules fructifications of Albugo in Albuginaceae on plant surfaces, especially on leaves e.g., white rust of Amaranthus caused by *Albugo bliti*, white rust of crucifers caused by *A. candida* and white rust of sweet potato caused by *A. ipomeae panduranae*.

White rust of crucifers - *A. candida*

Systematic position

Sub-kingdom: Mycota
Division: Eumycota
Subdivision: Mastigomycotina
Class: Oomycetes
Order: Peronosporales
Family: Albuginaceae
Genus: Albugo
Species: *A. candida*

Symptoms: The fungus attacks cabbage, cauliflower, mustard, radish and turnip. The disease name is a misnomer. The pustules formed by white rust resembles the aecial stage of true rust belonging to the subdivision Basidiomycotina and hence the name. All aerial plant parts viz., leaf, stem and inflorescence are affected. On the lower surface of leaves it causes white or creamy yellow pustules of various sizes and shape. They are shiny and 1 to 2 mm in dia. rarely the infection is seen on the upper leaf surface. Very often several of them coalesce to form patches.

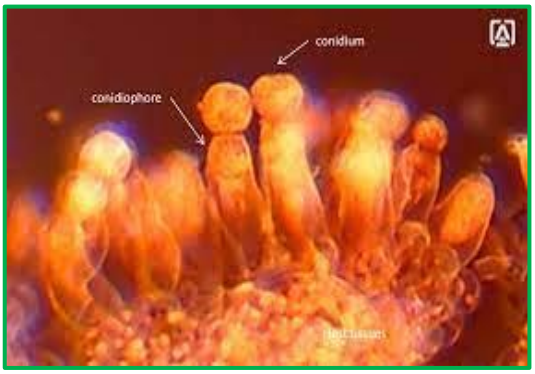
White rust on leaf

White rust stag head symptom

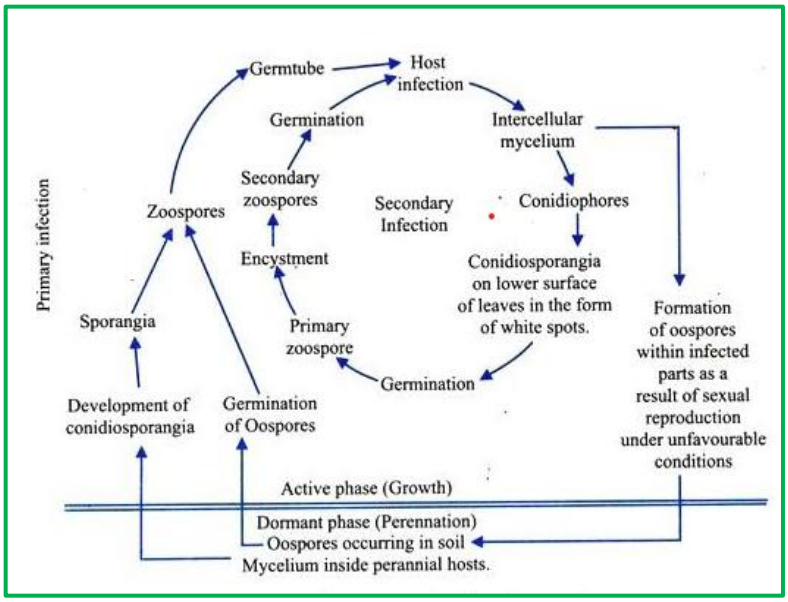
They are formed below the epidermis and are unbroken. But with the pressure of sporangia from below, they rupture the epidermis and appear as powdery masses on the surface of leaves. The leaves are not distorted. In severe cases, the infection spreads to the stem, which is uniformly swollen for a length of several centimetres. Lateral buds, which are normally latent, may proliferate resulting in a bushy growth. Flowers and peduncles are also attacked. Peduncles become enormously swol1en. Affected flowers show various discolouration and malformation. The petals become green and stamens turned into leaf-like structures. Sometimes they may be changed into thickened club-shaped sterile bodies.

The pistil is hypertrophied into a large conical, thick walled sac or transformed into a sterile capillary leaf. The fungal parasite stimulates cell activity leading to an abnormal increase in cell size (hypertrophy) and abnormal increase in cell division (hyperplasia) and formation of chlorophyll and starch at place where none is usually seen. Sepals become enlarged to several times than the normal sepals. Normally seed development is arrested. Pustules may occur on hypertrophied organ also

Pathogen: It is an obligate parasite. The thallus is eucarpic and mycelial. Mycelium is well developed, strictly intercellular, hyaline, non-septate (coenocytic) and branched. Haustoria are knob-like or globular. Sporangiophore is club-shaped, short, erect, non-septate, closely arranged, unbranched and thick walled. Sporangia are globose or hexagonal (flattened at the sides), hyaline, smooth, thin walled and produced in basipetal chains (oldest at the top and youngest at bottom) with isthmus. Sporangia are formed at the tip of the sporangiophores. Antheridia are clavate or club shaped, multinucleate and paragynous. Oogonia are globose, terminal or intercalary. Oospores are reticulate and round. Zoospores are biflagellate and Reni form and 4 to 8 per sporangium.



Disease cycle: In the asexual stage, hyphae aggregate at several places under the epidermis. Sporangiospores are formed as a palisade-like layer. These cut multinucleate sporangia, which remain, attached to form a chain at the apex. The oldest sporangia lie at the top and youngest at the base of the chain (called basipetal). The sporangia are separated from each other by a gelatinous disc-like structure called disjunction or isthmus. The disjunctions are dissolved by water and the sporangia are set free. The numerous sporangia that are produced at the apical end of sporangiophores push against the epidermis, which bulges out and ultimately breaks.



The areas with broken epidermis and creamy mass of sporangia appear as pustules or blisters on the leaves. Sporangia germinate by means of germ tube (direct germination) or by formation of zoospores (indirect germination). Direct germination is not common. Sexual reproduction occurs when the crop season comes to

an end and it is typically oogamous.

The antheridia and oogonia borne terminally on somatic hyphae. Plasmogamy takes place by gametangial contact, where the male nucleus from antheridium is transferred to oogonium through the fertilization tube. Karyogamy occurs and a thin membrane develops around the diploid zygote and a thick warty, tuberculate or roughened epispore. After a resting period, the oospore germinates and forms a vesicle, which contains 40-60 zoospores. The rupture of the vesicle wall releases the zoospores. The zoospore germinates by forming a germ tube, which infects the host plant.

Management: Practices like collection and burning of diseased plant material in order to prevent oospore formation.

1. Physical control

- Ploughing or disking diseased plants and plant parts results in rapid decomposition of infected tissues and helps to significantly reduce future white rust infection.
- Crop rotation with noncruciferous host plants is also effective. Weed control and other sanitary methods are necessary too.

A. Controlled watering

- A short, heavy watering is preferable to a long, light watering.
- Avoid night irrigations if possible.
- Reduction of humid conditions around the plants by maintaining proper spacing, crucifer weed free cultivation

B. Ventilation

- Maintain good air-flow within the crop to allow leaves to dry off quickly and minimise ideal infection conditions.

C. Nutrition

- Maintain a balanced nutrition program to reduce any stress on the plant.
- Application of fertilizers like phosphorus, potassium and avoidance of excess application of nitrogen keep the disease under check.

D. Hygiene

- Remove any sources for infection, such as volunteer radish, cruciferous weeds and crop debris.
- Ensure all equipment (bins, crates etc.) and machinery entering the farm has been thoroughly cleaned prior to arriving at the farm, preferably with a high pressure washer.
- Ensure that all staff and visitors entering the farm do not have soil and organic matter on their shoes and equipment.

2. Biological control through resistant varieties

- Resistance has been successfully deployed with mustard and rutabaga, however, with Asian vegetables such as Chinese mustard, Chinese cabbage, pak choi, and diakon, resistant varieties have not yet been identified.

3. Fungicides

- Many of fungicides that are effective against white blister are protectant fungicides and therefore need to be applied prior to the infection occurring.
- Rotating fungicide modes of action is also key in order to prevent the development of fungicide resistance.
- With the initiation of the disease, spray the crop with metalaxyl + mancozeb (0.25%) followed by sprays of Bordeaux mixture (4:4:50) or mancozeb (0.25%) or copper oxychloride (0.30%) and repeat at 10 to 14 days interval.
- Older fungicides used, but less effective, for white rust control include: Dithane Z-78, Blitox, wettable sulphur, fixed copper compounds, Bordeaux mixture, chlorothalonil, captofol, captan, dodine, mancozeb, metiram, maneb, and zineb.