Albugo

Classification

Kingdom	Fungi
Division	Eumycota
Subdivision	Mastigomycotina
Class	Oomycetes
Order	Peronosporales
Family	Albuginaceae
Genus	*Albugo*

White rust of crucifers is caused by Albugo candida. The disease is commonly known as white rust because it appears in the form of shiny, white, smooth pustules on the leaves, stems and other aerial parts of the plant. The pustules are initially formed on the lower surface of the leaf but in several cases they may be present on both the surfaces. With this several other effects are also produced. Increase in the size of the cells (hypertrophy) and organs takes place. It results in the formation of large galls on the various parts of the host. Severe infection causes proliferation of the lateral buds, discoloration of flowers, malformation of floral parts and sterile gynoecium.

Thallus

Thallus is eucarpic and mycelial. Hyphae are intercellular, coenocytic, aseptate and branched. Cell wall is composed of fungal cellulose. The protoplasm contains a large number of nuclei distributed in the cytoplasm. Reserve food material is oil and glycogen. Some mycelium is intracellular in the form of knob-like haustoria to absorb food from host.

Reproduction

The fungus reproduces both by asexual and sexual methods

Asexual Reproduction:

The asexual reproduction takes place by conidia, condiosporangia or zoosporangia. They are produced on the sporangiophores. Under suitable conditions the mycelium grows and branches rapidly. After attaining a certain age of maturity, it produces a dense mat like growth just beneath the epidermis of the host. These hyphae produce, at right angles to the epidermis are short, thick walled, un-branched and club shaped. These are the sporangiophores or conidiophores. They form a solid, palisade like layer beneath the epidermis. They are thick walled on lateral sides and thin walled at tip. The sporangiophores contain dense cytoplasm and about a dozen nuclei. After reaching a certain stage of maturity, the apical portion of sporangiophore gets swollen and is ready is cut off a sporangium or conidium. The sporangia are produced at the tip by

abstraction method. Thus along chain of sporangia or conidia is formed above each sporangiophore in basipetal succession (youngest at the base and oldest at the tip). The sporangia or conidia are spherical, smooth, hyaline and multinucleate structures. The walls between them fuse to form a gelatinous disc-like structure called disjunctor or separation disc or intercalary disc. It tends to hold the sporangia together. The continued growth and production of sporangia exerts a pressure upon the enveloping epidermis. Which is firstly raised up but finally ruptured exposing the underlying sours containing white powdery dust of multinucleate sporangia or conidia. The separation discs are dissolved by water, and the sporangia are set free. They are blown away in the air by wind or washed away by rain water under suitable environmental conditions and falling on a suitable host, sporangia germinates with in 2 or 3 hours. The sporangia germinate directly or indirectly depending on temperature conditions. At high temperature and comparative dry conditions the sporangium germinates directly. It gives rise to a germ tube which in-fact the host tissue through stoma or through an injury in the epidermis. In the presence of moisture and low temperature (10°C) the sporangium germinates indirectly i.e., it behaves like zoosporangium and produces zoospores. It absorbs water, swells up, and its contents divide by cleaving into 5-8 polyhedral parts depending upon the nuclei present in it. Each part later on rounds up and metamorphoses into zoospore. A papilla is developed on one side which later burst and liberates the zoospores. The zoospores are uninucleate, slightly concavo-convex and biflagellate. The flagella are attached laterally near the vacuole. Of the two flagella one is of whiplash type and the other tinsel type. After swimming for some time in water, they settle down on the host. They retract their flagella, secrete a wall and undergo a period of encystment. On germination, they put out a short germ tube which enters the host through stomata or again infects the healthy plants.

Sexual Reproduction:

The mycelium penetrates into the deeper tissues of the host. The sexual reproduction is highly oogamous type. The antheridium and oogonium develops deeper in the host tissue in close association within the intercellular spaces. Its formation is externally indicated by hypertrophy. The antheridium and oogonium are formed near each other on hyphal branches. They are terminal in position, however, intercalary oogonia also occur, though rarely.

Antheridium:

It is elongated and club shaped structure. It is multinucleate but only one nucleus remains functional at the time of fertilization in *C. candidus*. However, in *C. bliti* and *C. portulace* it is multinucleate at the time of fertilization and all the nuclei (nearly 100) remain functional. It is paragynous i.e., laterally attached to the oogonium. It is separated by a cross wall from the rest of the male hyphae.

Oogonium:

It is spherical and multinucleate containing as many as 65 to 115 nuclei. Mature oogonium has outer peripheral region of periplasm and the inner dense central region of ooplasm or oosphere or the egg. The ooplasm and periplasm are separated by a plasma membrane. The nuclei in the oogonium divides mitotically. The first mitotic division takes place before the organization of the periplasm and oosplasm. After the organization, all the nuclei of the ooplasm, except one, migrate to the periplasm forming a ring and undergo second mitotic division. They divide in such a manner that one pole of each spindle is in ooplasm and the other in the periplasm. At the end of the division one daughter nucleus of each spindle goes to the oosplasm and other in periplasm. However, at the time of maturity, all nuclei disintegrate, except single functional nucleus. On the basis of functional nuclei in ooplasm, Albugo is divided into following groups:

1. The number of functional egg nucleus in ooplasm is one. It is represented by *C. tragopogonis, C. candidus, C. evolvuli* etc.
2. The number of functional eggs in ooplasm is many. It is represented by *C. bliti, C. portulacae* etc.

It has been observed that in *C. portulacae* and *C. bliti* nearly 60 nuclei accumulate in the ooplasm and after fertilization they fuse with the male nuclei. However, in C. tragopogonis about a hundred female nuclei are present in the oosphere, but only one in functional. The rest of the nuclei disintegrate before fertilization.

Fertilization:

Before fertilization a deeply staining mass of cytoplasm, appears almost in the centre of the ooplasm. This is called coenocentrum. It persists only up to the time of fertilization. The functional female nucleus attracted towards it and becomes attached to a point near it. The oogonium develops a papilla like out growth at the point of contact with the antheridium. This is called as receptive papilla. Soon it disappears, and the antheridium develops a fertilization tube. It penetrates through receptive papilla, oogonial wall and periplasm and finally

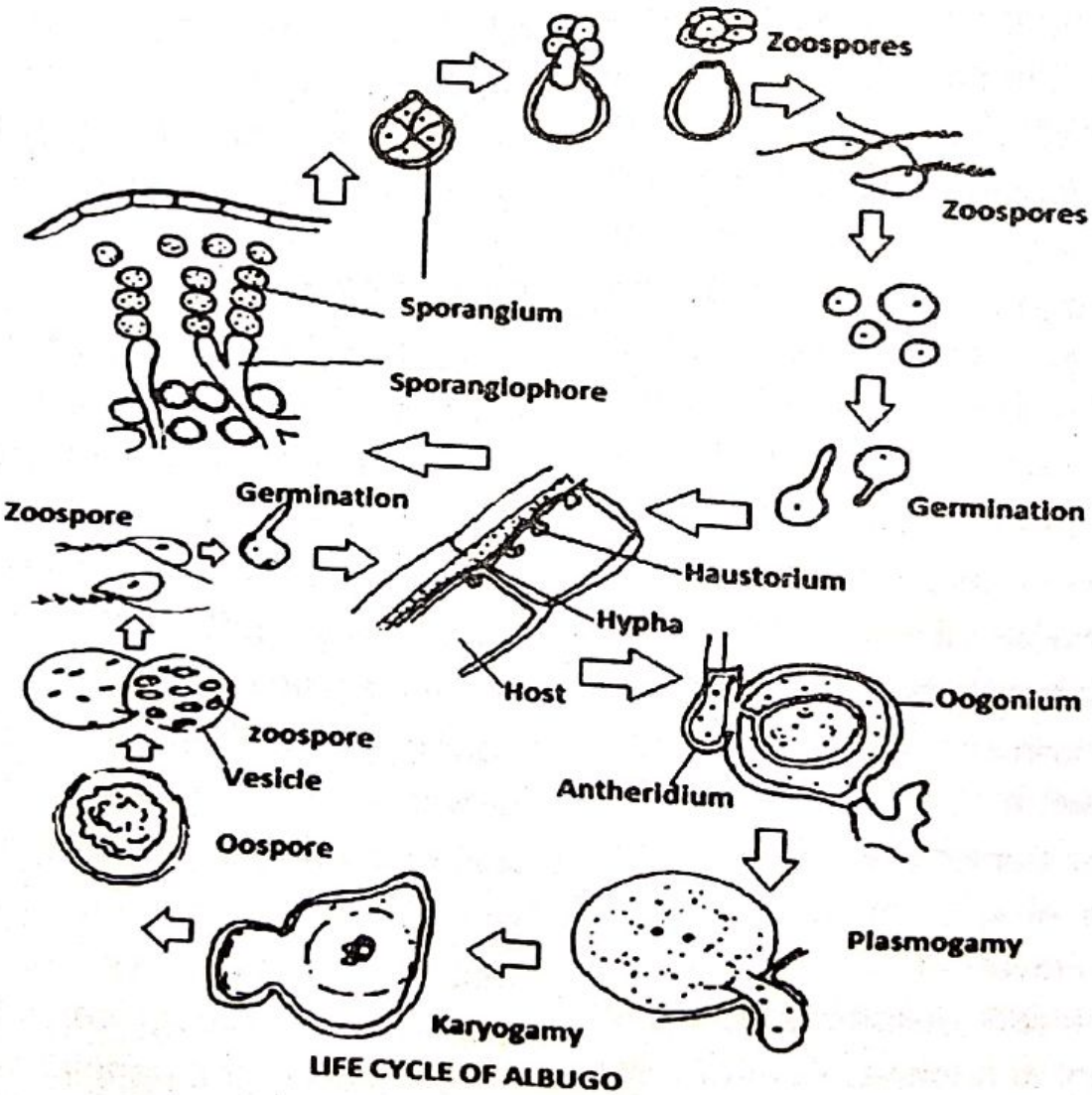
reaches upto the ooplasm. It carries a single male nucleus. Its tip ruptures to discharge the male nucleus near the female nucleus. Ultimately the male nucleus fuses with the female nucleus (karyogamy).

Oospore:

The oospore alongwith the fusion nucleus is called oospore.

1. In *C. tragopogonis* and C. candidus, one male functional nucleus fuses with one female functional nucleus. So, the oospore is uninucleate.
2. In C. portulaceae and C. blit oospore is multinulceate consisting of nearly 60 functiona nuclei. The same number o functional male nuclei are discharged by the fertilization tube. Both male and female nucle fuse, and the oospore produced in these species in multinucleate.

Such oospore is called a compound oospore. The oospore on maturity secretes a two to three layered wall. The outer layer is thick, warty or tuberculated and represents the exospore. The inner layer is thin and culled the endospore.



LIFE CYCLE OF ALBUGO