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RESEARCH ARTICLE

Morphotaxonomy of powdery mildew fungus (*Golovinomyces cichoracearum* DC) on *Helianthus petiolaris*

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SUMMARY

The powdery mildew disease caused by *Golovinomyces cichoracearum* on *Helianthus petiolaris* recorded for the first time from New Delhi, India. The symptoms of disease appeared in the first week of March on the upper surface of leaves and then on other green parts of the plant. The development of few cleistothecia on the upper surface of leaves was also observed in the last week of April, when conidial production was slowed down and ceased. The infected plants remained stunted due to reduction in size and number of the leaves. Although the host range of powdery mildew caused by *Golovinomyces cichoracearum* has been previously described, no full description and illustration of the infection, including symptoms and signs on *Helianthus petiolaris*, has yet appeared. This is the first description of powdery mildew on *Helianthus petiolaris*, featuring taxonomic identification, symptoms, and signs.

Key Words : Chasmotheca, *Golovinomyces*, Fibrosin body, Ascomata

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Powdery mildew causing pathogens are ascomycetous obligate parasites, which grow principally on foliage of angiosperms and cause damage to a wide variety of crops. The fungus attacks, flowers, stems and fruits of plants. Initial symptoms are very mild producing small patches on the host, later it becomes chlorotic and may kill the whole plant as a result of severe infection. The pathogen is characterized by their superficial powdery white hyaline mycelium and haustoria in the epidermal cells of the hosts. Large number of cultivated and wild species of different families has been recorded as the hosts of the members of Erysiphaceae. A considerable amount of damage by this fungus has also been recorded on different crops (Paul and Mujal, 1982).

Helianthus petiolaris grow as weed in several areas of New Delhi region, but known for its ornamental value. During the survey of fungal diseases of crop plants in and around New Delhi it was observed that some of

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the plants *viz*., *H. petiolaris* were heavily infected with the powdery mildew disease. Therefore, it was found desirable to conduct an investigation on the identification of causal agent of powdery mildew disease of *Helianthus petiolaris*.

MATERIAL AND METHODS

A survey was conducted in and around the I.A.R.I campus to determine the incidence of powdery mildew disease on several weeds. For identification of pathogen, twigs of *Helianthus petiolaris*, infected with powdery mildew disease were collected from different localities. Samples were packed in polythene bags and labelled to indicate the location and date of collection. These samples were brought to the laboratory for further studies.

Surface structures were stripped off with double-sided clear adhesive tape, mounted with the specimen's surface uppermost either dry or in 3% aqueous potassium hydroxide for examination under the compound microscope with, or without, Nomarski illumination. Conidia were also examined in air by simply pressing a slide against an infected leaf with, or without, an intervening layer of the samples were observed under a light microscope (Olympus model BX41TF, Olympus Corporation, Tokyo, Japan), images were taken with a digital Olympus DP20 camera, and its software was used to measure hyphae, appressoria, conidiophores, conidia, chasmothecia, asci, and ascospores. The dried samples were rehydrated with a 3% KOH solution as needed. The morphological characterization of the species was made by comparing the holomorphic characteristics of the fungus those described in the monographs of Erysiphales (Bolay, 2005 and Braun, 1987), conidia germination pattern was assessed according to the key proposed by Cook and Braun (2009).

Anamorph characters which were used in the identification of powdery mildew species, mode of parasitism in relation to ectophytic and endophytic nature of the mycelium, Morphology of conidiophores, length of the conidiophores (number of cells), length of foot cells, arrangement of conidia on conidiophores, shape of conidia, length/breadth (L/B) index, presence and absence of fibrosin bodies in conidia, morphology of germ tube and appressoria. Teleomorphic studies, the slides were made by picking up individual ascoma directly from the specimens and mounted it in lactophenol cotton blue drop on a glass slide and then applied a cover glass. The external morphology of the ascomata was examined under the microscope. These ascomata were crushed by applying a gentle pressure with a blunt end of the needle in order to get a clear picture of the centrum.

To study conidial germination conidia were procured through the contact of mildewed leaves with clean dry 3x 1" glass slides or by shaking the leaves over the slides. These were placed in drops of 2% sucrose solution and a trace of indole acetic acid in cavity slide and incubated in dark at 24^0C + 1 in a water saturated atmosphere in plastic Petri plates for 18 to 24 hours sometimes requiring upto 72 hours depending upon the species and age of the fungus. The details of germ tube and appresoria, their size and shape were recorded. For every specimen 100 measures of conidia, ascomata, and other structures of the fungus were taken under high power of the microscope. Care had been taken to avoid measuring immature conidia and chasmotheca and those which were not oriented with their long axis parallel to cover glass. The collected samples were submitted in HCIO (ID No. 51860).

RESULTS AND DISCUSSION

The powdery mildew symptoms appeared in the first week of March on the upper surface of leaves and then on other green parts of *Helianthus petiolaris*. Its attack was characterized by the formation of whitish grey, dusty or floury patches (lesions) on both sides of the leaves and younger part of stem. With the advancement of disease, the white spots increased in numbers and size, coalesce and eventually covered the entire, both, upper and lower surfaces of the leaves (Fig 1). This superficial floury mass consisted of large number of conidia and mycelia of the fungus causing the disease. Infected plants remained stunted due to reduction in size and number of the leaves. Black, pin point bodies, representing the fruiting body of the fungus developed only in few infected dried leaves. The healthy plants were inoculated by leaf rubbing method which gave same symptoms and hence pathogenicity is established.

Species description:

Golovinomyces cichoracearum U. Braun, *Beih, Nova Hedwigia* 89: 248, 1987 :

Mycelium amphigenous, effuse or in white patches; hyphae branched, septate, 3–10 μm wide, hyaline, thin-walled, smooth; appressoria solitary, occasionally with two nipple-shaped appressoria per cell, occasionally with slightly crenate surface, 4 – 8 μm diameter ;

conidiophores arising from superficial hyphae, position between two septa more or less central to usually non-central, erect, straight, foot-cells of 44 –160 x 11 –16 µm size, sub-cylindrical to usually slightly increasing in breadth from base to top [8 –11 µm wide at the base and 10 –13 µm wide above], occasionally slightly curved at the very base, foot-cells followed by 1–3 short cells; conidia in long chains (Fig. 2), broadly ellipsoid-ovoid, doliform, limoniform, (23-46 µm length, and 14-22 µm breadth, length/breadth ratio >2, mostly 2.04–2.26, fresh conidia with large oil drops, germ tubes sub-terminal to somewhat lateral, some germ tubes were short, tips with a slightly swollen appresorium, but most germ tubes long and narrow, upto six times as long as the conidial length after one day of germination and nonswollen tips. In *G. cichoracearum*, the average diameter of the chasmothecia ranged between 85-160 µm with 2 to 25 asci containing only 2 ascospores per ascus (Fig. 4). The ascospores are one-celled, primarily straight and their size range is 18-30 x 11-20 µm. Electron microscopy revealed light wrinkling on conidia (Fig. 3).

Powdery mildews are some of the world's most frequently encountered plant pathogenic fungi, infecting leaves, stems, flowers and fruits of nearly 10 000 species of angiosperms in addition to infecting many economically important plants. Detailed examination of

Fig. 1 : Powdery mildew affected plants

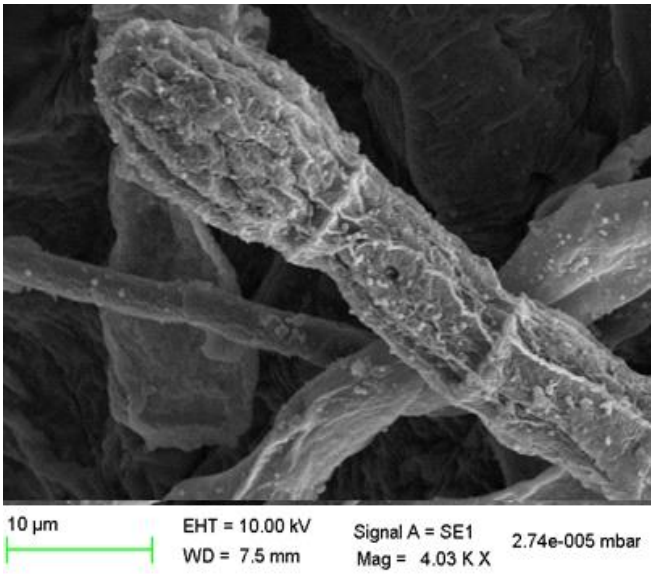

Fig. 3 : Electron microscopic images

Fig. 2 : Conidia and conidiophores

Fig. 4 : Cleistothecia

Fig. 5 : Germinated conidia

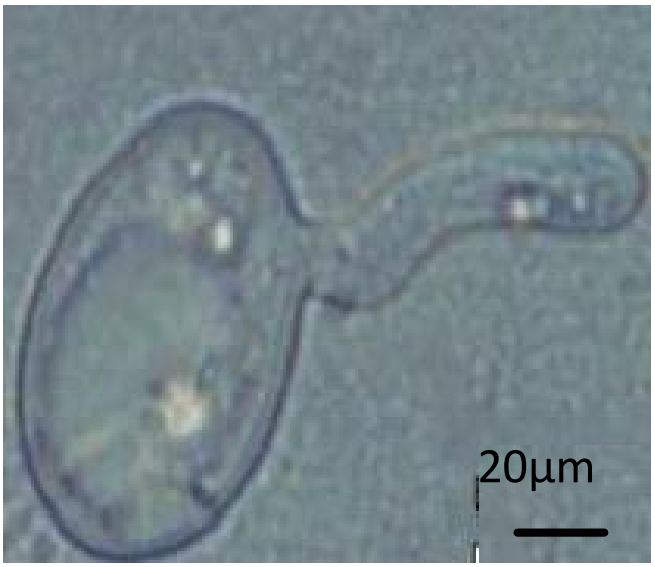

Fig. 6 : Opened Cleistothecia with ascus

samples of wild sunflower revealed the presence of fungus *Golovinomyces cichoracearum* in the surveyed area.

Morphological characteristics of anamorphs and teleomorphs have been widely used among researchers to distinguish between powdery mildew genera. Sharma and Khan (1994) argued that conidial dimensions within the Erysiphaceae fungi overlap, and have little diagnostic value. However, conidial length/width ratios have been reported to reliably distinguish between *P. xanthii* and *G. cichoracearum* (Salmon, 1900). Furthermore, since ascal structures vary with environmental conditions and do not develop on all hosts, conidial observations are more generally useful (Zhou *et al.*, 2010). But in our study occurrence of chasmothecia of fungi have added one additional dimension in identification of genera. It may be possible that inoculum surviving on the weed host may also serve as source of primary infection in host so detailed study needed in order to reveal cross infectivity and there is possibility of these weed species acting as alternate or collateral host of powdery mildew of wild sunflower. The complete life cycles of most species of powdery mildew genera are unknown. Obtaining such information will be necessary to clarify species concepts and to provide information about disease cycles that can be used to develop control strategies.

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