

## First report of powdery mildew of *Plantago lanceolata* caused by *Podosphaera plantaginis* in India

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### ABSTRACT

The powdery mildew infection on the leaves of *Plantago lanceolata* was observed in the Mandi district of Himachal Pradesh. After the analysis of the morphological characteristics of diseased samples, the powdery mildew pathogen was identified as *Podosphaera plantaginis*. This fungus reflects its major distribution in Europe but also marks its presence in America, Australia and Asia. In Asia, it is reported from Armenia, Iran and Russia, but has not been reported from India. Therefore, this study provides the first report of *Podosphaera plantaginis* on *P. lanceolata* in India.

**Key words:** Plantain, erysiphales, powdery mildew, new report

### INTRODUCTION

*Plantago lanceolata* is a common weed in the plantain family *Plantaginaceae*. It is a perennial flowering plant that was once native to Europe and Asia, but is now a prevalent weed all over the world (Xiaolong et al. 2019). It is typically found in meadows with neutral to alkaline soils, roadside strips, pastures, and clearings. The plant is characterized by alternate, lanceolate to lance-oblong-shaped, entire or slightly toothed basal leaves up to 40 cm long (Pol et al. 2021). Although these plants can bloom in April and last until the first frosts, they need long days to stimulate flowering, which occurs between May and August. For centuries, this plant has been used for cooking and in medicine. Leaves and seeds of this plant offer several health advantages, including increased immunity, anti-bactericidal properties, accelerated skin regeneration, and relief from toothaches, bites from bugs, and snakes. They are used externally in treating skin inflammations, malignant ulcers, cuts, stings, etc. (Bond et al. 2007; Abate et al. 2022).

In this study, we observed the occurrence of powdery mildew on the leaves of *P. lanceolata* in the Mandi district of Himachal Pradesh. The powdery mildew infection appeared as white-greyish mycelial growth on the leaf surface. The objective of this study was to identify the fungal pathogen associated with the powdery mildew disease of *P. lanceolata*.

### MATERIALS AND METHODS

The leaf samples showing powdery mildew symptoms were collected in labelled paper bags. The collected samples were brought to the laboratory immediately after collection for further studies. The leaf samples were first examined with a hand lens and thereafter with a dissecting microscope. For microscopic observations, a piece of clear adhesive tape (cello tape) was placed and pressed gently on the surface of an infected leaf and then stripped off. Thereafter, it was placed on a microscopic slide with one drop of clear distilled water or lactophenol cotton blue and observed under a compound microscope to observe the various morphological characters. The microscopic structures were analyzed, photographed and measured. All microscopic characteristics as described by Braun & Cook (2012) were used to identify powdery mildew fungi.

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## RESULT AND DISCUSSION

The primary symptoms of the powdery mildew appear as circular, small, white-greyish powdery patches of mycelial growth on the adaxial leaf surface, producing asexual structures throughout the summer and chasmothecia in winter. As the samples were collected during winter, the sexual structures were observed more prominently instead of asexual structures, like mycelium, conidiophores, conidia and appressorium. These patches can expand and may lead to yellowing, curling, and premature defoliation of the leaves. The early defoliation of leaves can lead to reduced plant vigor. After analyzing the morphological and microscopic characteristics, the fungus was identified as *Podosphaera plantaginis* (Castagne) U. Braun & S. Takam.

### Taxonomy

*Podosphaera plantaginis* (Castagne) U. Braun & S. Takam., Schlechtendalia 4: 31 (2000) **Fig. 1**

Bas.: *Erysiphe plantaginis* Castagne, Cat. Pl. Mars.: 188 (1845).

= *Sphaerotheca plantaginis* (Castagne) L. Junell, Sv. Bot. Tidskr. 60(3): 382 (1966)

≡ *Erysiphe plantaginis* Castagne

= *Sphaerotheca plantaginis* (Castagne) U. Braun & S. Takam.

= *Erysiphe lamprocarpa e plantaginis* Rabenh., Deutschl. Krypt-Fl. 1: 232, 1844.

≡ *Sphaerotheca castagnei f. plantaginis* (Rabenh.) Rabenh., Fungi Eur. Exs. 1048, 1866.

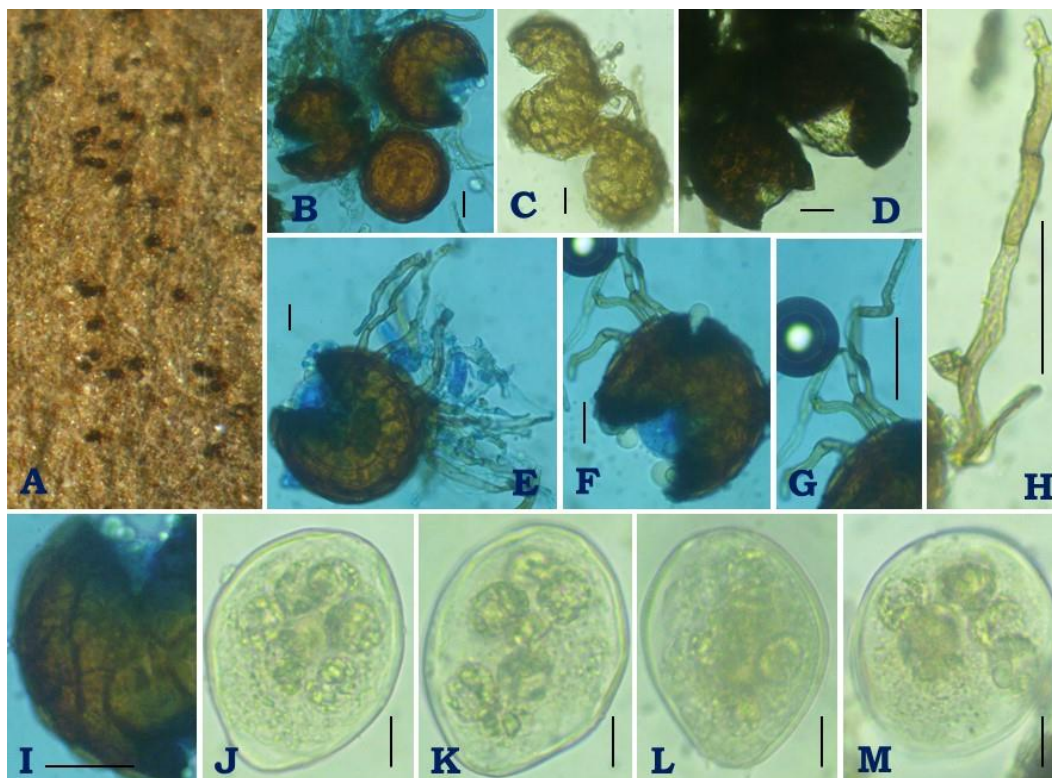
= *Erysiphe lamprocarpa f. plantaginis-lanceolatae* Sacc., Mycoth. Ven. 611, 1876.

= *S. fuliginea f. plantaginis* Duby (Jaczewski 1927: 102).

= *S. fuliginea* auct. p.p.

= *S. humuli var. fuliginea* auct. p.p.

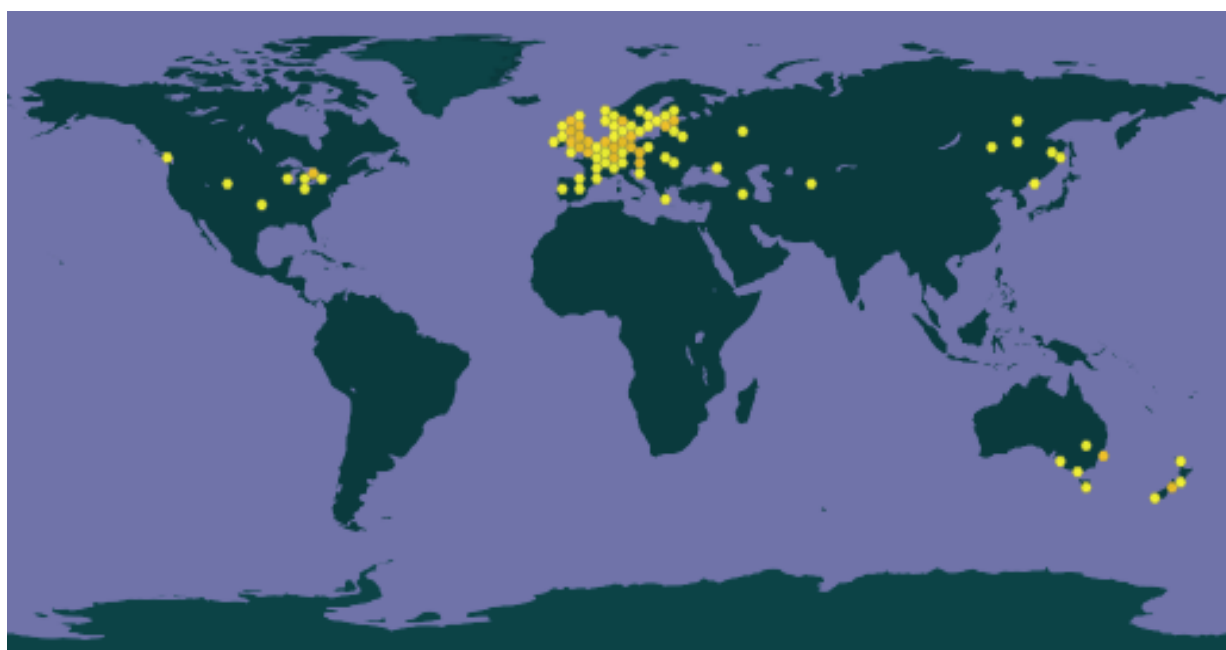
The fungus is characterized by thin and amphigenous mycelium, appearing as irregular patches or effuse, evanescent or persistent, white or greyish white. The hyphae were observed hyaline, septate, thin-walled, almost smooth, with nipple-shaped appressoria. The conidiophores erect with cylindrical foot-cells ( $41\text{--}70 \times 10\text{--}14 \mu\text{m}$ ), followed by 0–2 shorter cells forming a chain of ellipsoid-doliiform conidia ( $27\text{--}36 \times 16\text{--}21 \mu\text{m}$ ) with a length/width ratio below 2. Chasmotheca are sporadic to gregarious, with a diameter of  $70\text{--}104 \mu\text{m}$ ; peridium cells are irregularly polygonal, with a  $10\text{--}40 \mu\text{m}$  diameter. Appendages, few to many or sometimes almost absent, on the lower half; simple, rudimentary, rarely branched, and consistently short, either as long as or shorter than the chasmothecial diameter. Two types of appendages are often seen with varied width ( $4\text{--}11 \mu\text{m}$ ); narrow or hyaline to yellowish, or coarse and brown throughout, smooth, thin-walled and septate. The asci produce singly and are mostly immature, broadly ellipsoid-ovoid to subglobose ( $54\text{--}80 \times 50\text{--}71 \mu\text{m}$ ), containing (6–) 8 ellipsoid-ovoid to subglobose, colorless ascospores.



**Figure 1.** Powdery mildew of *P. plantaginis* on *P. lanceolata*. A) infected leaf with Chasmothecia; B-E) Chasmothecia with single ascus; F-H) Chasmothecia with septate appendages; I) outer surface of Ascus; J-M) Ascus with Acospores. (Scale bars: B-I=20  $\mu\text{m}$ , J-M=10 $\mu\text{m}$ ).

**Note:** The earliest record of powdery mildew on *Plantago* sp. has been traced back to Salmon (1900), who identified it as *Erysiphecichoracearum*. However, Sawada (1927) established it as a separate species of *Erysiphe* as *E. plantaginis* (Link) Sawada. It is also declared illegitimate (Nom. illegit., Art. 53.1), as it is a later homonym of *E. plantaginis* Cast. (1845). Currently, *E. plantaginis* Cast. (1845) is known as *P. plantaginis* (Castagne) U. Braun & S. Takam. Powdery mildew on *Plantago* spp. is primarily reported to be caused by two fungal pathogens: *Podosphaera plantaginis* and *Golovinomyces sordidus* (formerly known as *Erysiphe sordida*). However, the microscopic characters, such as chasmothecium containing a single ascus and bearing simple, hypha-like appendages, resembled those of *P. plantaginis* (Braun & Takamatsu 2000, Braun & Cook 2012 and Schmidt & Braun 2020).

This confirms the identity of powdery mildew as *Podosphaera plantaginis* (Castagne) U. Braun & S. Takam. Several earlier studies on different species of *Plantago* depicted the association of diverse powdery mildew fungi. The *Erysiphe sordida* var. *spitiana* on *P. tibetica* and *Erysiphe sordida* var. *similensis* on *P. tibetica* have been reported earlier from Himachal Pradesh, India (Paul & Thakur 2006). Similarly, *Golovinomyces* sp. on *P. australis* and *Golovinomyces sordidus* on *P. major* were reported from Brazil (Dallagnol et al. 2013) and Vietnam (Tam et al. 2015), respectively. The *P. plantaginis* was studied as an obligate pathogen specific to its host plant *P. lanceolata* L. (*Plantaginaceae*) by Tollenare and Laine (2013). The presence of *P. plantaginis* in Australia was confirmed by Kiss et al. (2020); however, they also reported this fungus on *Lactuca serriola* in Western Australia.



**Figure 2.** Global distribution of *P. plantaginis* (Source: <https://www.gbif.org/species/5255366>)

As per GBIF (2024), there are about 589 reports of *P. plantaginis* on *P. lanceolata* reported from 32 countries of the world. The global distributional analysis revealed that the occurrence of this fungus on *P. lanceolata* has already been reported from Europe (Belarus, France, Germany, Poland, Russia, Serbia and Montenegro, Sweden, Switzerland & Ukraine), Asia (Armenia, Iran & Russia), South America (Argentina) and Australia (Braun & Cook 2012; Kiss et al. 2020; Farr & Rossman 2025). A global distribution map for this fungus is presented in Figure 2. However, no report has been encountered from India (Bilgrami et al. 1991; Jamaluddin et al. 2004; Gautam & Avasthi 2018 and Manoharachary et al. 2022). Therefore, we propose this as the first report of *Podosphaera plantaginis* on *Plantago lanceolata* from India.

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