BIOTROPIA ISSN: 0215-6334 | e-ISSN: 1907-770X
The Southeast Asian Journal of Tropical Biology
Vol. 33 No. 2, 2026: 260 - 265
DOI: 10.11598/btb.2026.33.2.2505

Short Communication

Check for updates

OCCURRENCE OF POWDERY MILDEW CAUSED BY *Podosphaera* sp. ON INVASIVE WEED *Ageratum houstonianum* IN NEPAL

Hari Sharan Adhikari[1,2*], Lal bahadur Thapa[3], and Sanjay Kumar Jha[3]

[1]Department of Botany, Bhaktapur Multiple Campus, Tribhuvan University, Bhaktapur 44800, Nepal
[2]Department of Botany, Amrit Campus, Tribhuvan University, Kathmandu 44613, Nepal
[3]Central Department of Botany, Tribhuvan University, Kathmandu 44613, Nepal

ARTICLE HIGLIGHTS

- First report of *Podosphaera* sp. on invasive *Ageratum houstonianum* in Nepal.
- Pathogen identified by unique cask-shaped conidia, chasmothecia and fibrosin bodies.
- Potential biocontrol agent discovered for managing this invasive weed.
- This weed can act as a pathogen reservoir; monitoring is essential to protect nearby crops.

Article Information

Received : 26 March 2025
Revised : 12 February 2026
Accepted : 20 February 2026
Published Online : 8 May 2026

***Corresponding author, e-mail:**
aharisharan@gmail.com, hari.adhikari@ac.tu.edu.np

ABSTRACT

Ageratum houstonianum is an invasive annual weed in Nepal that grows in diverse habitats such as fallow areas, crop fields, and roadsides. This study reported a powdery mildew disease on this weed species, which causal agent was identified as *Podosphaera* sp. Pathogen identification was based on symptomatology and micromorphological observations. The pathogen was characterized by slightly dark, branched and septate hyphae with nipple-like appressoria; straight and unbranched conidiophore; hyaline and cask-shaped conidia with fibrosin-like bodies. Immature chasmothecia with mycelium-like appendages were also observed. The asci were ellipsoidal with a thin oculus. Based on the literature, the fungus was first reported in Nepal on *Ageratum houstonianum*. This report expands the known geographical distribution and host range of this powdery mildew pathogen in South Asia and highlights the pathogen as a potential biocontrol agent for this invasive weed. Additionally, *A. houstonianum* is common in agroecosystem, thus, it can serve as a reservoir of *Podosphaera* sp. facilitating spread to crop plants. Therefore, careful utilization, monitoring, and management of the pathogen are essential both to control the host weed and to limit the spread of pathogen to crops.

Keywords: blue goat weed, chasmothecia, Erysiphaceae, host range, *Sphaerotheca*

INTRODUCTION

Powdery mildew is a fungal disease caused by various species of ascomycetous fungi and affects a wide range of agricultural crops, weeds, and wild plants. Powdery mildew fungi are obligate pathogens that depend on living host cells for growth and development (Panstruga 2003). According to Adhikari (2022), 13 genera and 53 species of powdery mildew-causing fungi were reported on 76 flowering plant species from different regions of Nepal.

Ageratum houstonianum Mill. (Asteraceae) is an annual herbaceous plant native to Mexico and Central America (Johnson 1971) that has spread across most of the tropical to temperate regions of Asia, Europe and Australia (CABI 2022). This weed is widely recognized as one of the most problematic species in Nepal, with extensive distribution across mid-hill and lowland regions, including roadsides, gardens, protected areas, agricultural land, community forests, and fallow land (Shrestha *et al.* 2019). It reduces agricultural productivity, depletes soil fertility, and competes with native plants. It also causes cattle poisoning and reduces fodder availability (Bhatta *et al.* 2022; Pal *et al.* 2011). Furthermore, the weed alters soil physicochemical characteristics, competes for resources, releases allelochemicals, and interferes with pollination (Shrestha *et al.* 2018; Shrestha *et al.* 2019).

Globally, *A. houstonianum* is affected by several diseases, including downy mildew (caused by fungus *Plasmopara halstedii*), powdery mildew (caused by *Podosphaera xanthii*.), leaf blight (induced by *Botrytis cinerea*), and root rot (caused by *Phytophthora* and *Pythium*) (Bose *et al.* 2025; Baiswar *et al.* 2008; Pisani *et al.* 2019; Reeves *et al.* 2022; CAES 2022). However, reports of these diseases in Nepal are very limited.

In October 2020, a severe outbreak of powdery mildew on *A. houstonianum* was observed in a sal (*Shorea robusta*) forest located in Kailali District of far-western Nepal. Accordingly, this study was conducted to identify the causal organism responsible for the disease and to evaluate its potential as biocontrol agent for invasive weeds like *A. houstonianum.* In addition, the weed may act as a reservoir for powdery mildew pathogens, posing indirect risks to nearby crops and native flora (Yeh *et al.* 2021; Singh *et al.* 2023).

MATERIALS AND METHODS

Field Survey

Barhaban Collaborative Forest, Gauringanga Municipality-6, Kailali District of Sudurpashchim Province, Nepal (28°48'34.34" N, 80°40'37.63" E; altitude 204 m asl) was surveyed in October 2020. During transect walks along roadsides and trails across the forest, forest edges and within the forest interior, *Ageratum houstonianum* was widely distributed as an invasive weed across all surveyed habitats. Powdery mildew symptoms were frequently observed on the weed population at multiple locations.

Collection of Disease Samples

At each representative site (roadsides, trails, and forest edges), *A. houstonianum* plants were inspected (n = 30). From each site, five symptomatic leaves were collected, placed in sterile paper bags, properly labelled with sample ID and collection date, and stored in a gel icebox for transport. The photographs of infected plants and symptomatic leaves were also taken in situ. Leaf samples and herbarium specimens (voucher no. WS-KL-1252 & WS-KL-1266) were transported to the Plant Pathology Laboratory at the Forest Research and Training Center (FRTC), Department of Forest, Government of Nepal, Kathmandu.

Microscopy and Measurements

Powdery mass from diseased leaf surface was transferred onto microscope slides using the Scotch tape method (Larone 1995) and mounted in lactophenol cotton blue (LPCB) staining. Slides were examined under 100X, 400X and 1000X magnifications using an OPTIKA Trinocular Microscope B-293 to observe mycelia, appressoria, chasmothecia, conidia, asci, and conidiophores. All micromorphologi calcharacteristics were documented and photographed, while measurements were taken for each structure. The fungus observed was identified using the keys of Braun and Cook (2001) and Amano (1986). Molecular confirmation was not performed due to resource limitations. Morphometric measurements were made using ImageJ software (version 1.48).

RESULTS AND DISCUSSION

Powdery mildew symptoms on *Ageratum houstonianum* were documented at the study site. Infected leaves exhibited multiple oval to irregular patches of grayish-white powdery growths. As colonies matured, they coalesced to form dense white masses across the leaf lamina (Figure 1B, C). Microscopic examination showed that the powdery growth on the upper leaf surface comprised epiphytic mycelia and conidia (Figure 1C). Symptoms were less conspicuous on the lower leaf surface. Severe infection caused leaf necrosis, defoliation, and plant collapse (Figure 1A).

Powdery mildew disease caused by *Podosphaera xanthii* has been previously reported on *Ageratum conyzoides* in India, Pakistan and China (Nadeem *et al.* 2018; Mukhtar *et al.* 2013; Mukhtar & van Peer 2017). The pathogenic genus *Podosphaera* associated with powdery mildew disease on *Ageratum houstonianum* was first reported in India by Baiswar *et al.* (2008) and later confirmed as *Podosphaera xanthii* by Bose *et al.* (2025). These findings highlight the widespread occurrence of *Podosphaera* species as causal agents of powdery mildew in *Ageratum.*

Hyphae of currently reported pathogen were found to be septate, slightly dark, branched, 4.01 – 5.91 µm (n = 10) wide with nipple-like appressoria (Figure 1F). Conidiophores were straight and unbranched, foot-cells cylindrical with basal septa, 50.75 – 117.72 × 4.24 – 7.57 µm (n = 8), followed by one to three shorter cells (Figure 1D). Conidia were single borne or sometimes in chains, hyaline, barrel shaped (blunt rectangular type or somewhat

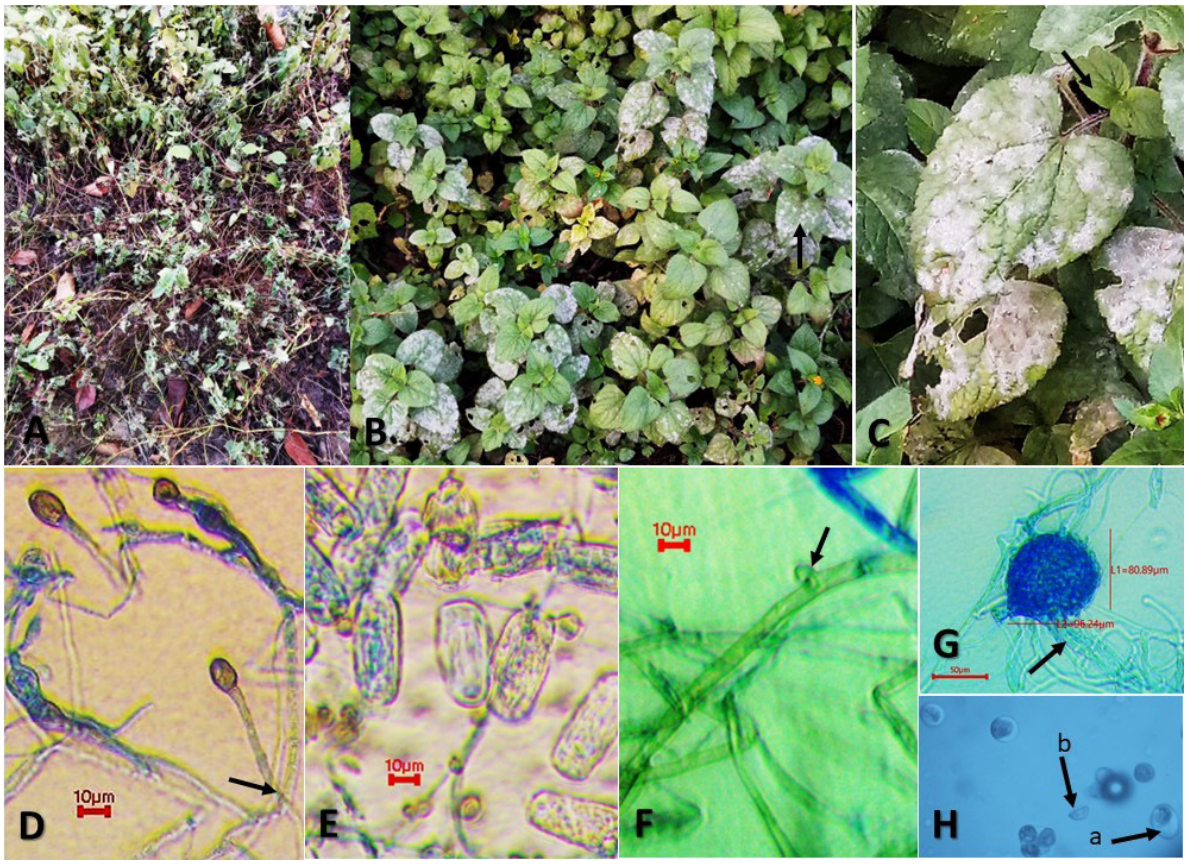

Figure 1 Powdery mildew on *Ageratum houstonianum*.

Notes: A = Destruction of *Ageratum houstonianum* due to severe infection by *Podosphaera* sp; B = Infected plants with initial infestation (arrow); C = Characteristic symptoms of disease on mature leaves with necrotic lesion and unaffected young leaves (arrow); D = Conidiophores with single conidium and basal septum (arrow); E = Conidia; F = Septate mycelium with nipple-like appressorium (arrow); G = an immature chasmothecium with lateral mycelial appendages (arrow); H = Asci showing thin oculus (arrow a) and deformed ascus without ascospore (arrow b).

ellipsoidal too), 31.95 – 43.52 × 14.72 – 18.63 µm (n = 10) sized with fibrosin-like bodies (Figure 1E). Immature chasmothecia (formerly cleisthothecia) of size 64.37 – 135.64 µm (n = 15) in diameter with appendages of mycelium-like bodies were also observed (Figure 1G). The asci were ellipsoidal with diameter of 45.61 – 63.59 µm (n = 5) with a thin-layer ascus wall i.e., oculus (Figure 1H, arrow a). Some deformed empty asci were also observed (Figure 1H, arrow b), while no ascospores were observed. These measurements were compared with three most common species of *Podosphaera* causing powdery mildew frequently in plants (Tabel 1). The measurements were consistent with the taxonomic description of *Podosphaera xanthii* (Baiswar *et al.* 2008; Braun & Cook 2012).

Based on micromorphological characters, the pathogen on *A. houstonianum* was identified as *Podosphaera*, with *Sphaerotheca* as a known synonym. The micromorphological measurements were consistent with *Podosphaera xanthii* sensu lato. However, molecular analyses were not carried out in this study due to resource limitations. Therefore, DNA sequencing is essential and recommended to confirm species-level identification of the pathogen.

Previous studies have confirmed *Podosphaera xathii* as the pathogen causing powdery mildew disease on *Ageratum conyzoides* (congeneric member of *A. houstonianum*) across South to East Asia (Aumentado *et al.* 2023), including Pakistan (Mukhtar *et al.* 2013), India (Amano 1986; Thite *et al.* 2017), China (Mukhtar & van Peer 2017) and Thailand (Meeboon *et al.* 2018). Powdery mildew on *A. houstonianum* caused by *Podosphaera* has been reported only from India (Baiswar *et al.* 2008), and was recently confirmed as *Podosphaera xanthii* by Bose *et al.* (2025). This study also resolved the taxonomic ambiguity with *Podosphaera fusca,* as both names were shown to represent the same species.

Table 1 Comparison of the micromorphological characters of the *Podosphaera* sp.

Species	Hyphae and appressoria	Conidiophore	Conidia	Chasmothecia	Asci	Oculus	References
Podosphaera sp	Hyphae superficial; nipple-like appressoria, 4.01 – 5.91 µm;	50.75 – 117.72 × 4.24 – 7.57 µm	Ellipsoidal or blunt rectangular; 31.95 – 43.52 × 14.72 – 18.63 µm; fibrosin-like bodies present	64.37 – 135.64 µm diameter; appendages mycelium-like	1 – 3 per chasmothecium, 45.61 – 63.59 µm diameter	Distinct	Present study
Podosphaera xanthii	Hyphae superficial; nipple-like appressoria, 6 – 10 µm	40 – 80 µm long	Ellipsoid, 20 – 35 × 12 – 20 µm; fibrosin-like bodies present	80 – 120 µm diameter; appendages mycelium-like	2 – 3 per chasmothecium, 40 – 65 × 25 – 35 µm	Distinct 5 – 8 µm	Choi *et al.* (2022)
Podosphaera leucotricha	Hyphae superficial; appressoria 6 – 9 µm	50 – 90 µm long	Cylindrical to ellipsoid, 18 – 30 × 10 – 15 µm	90 – 130 µm diameter; appendages flexuous	6 – 8 per chasmothecium, 35 – 55 × 20 – 30 µm	Thickened, 5 – 7 µm	Strickland *et al.* (2021)
Podosphaera aphanis	Hyphae dense; appressoria 5 – 8 µm	40 – 70 µm long	Ellipsoid, 18 – 28 × 10 – 15 µm	70 – 110 µm diameter; hypha-like appendages	4 – 6 per chasmothecium, 30 – 50 × 18 – 25 µm	Visible, 4 – 6 µm	Nadeem *et al.* (2018)

Podosphaera xanthii is a polyphagous, obligate biotroph capable of colonizing diverse hosts belonging to the Asteraceae and Cucurbitaceae (Polonio *et al.* 2019). Infection caused by this pathogen on *A. houstonianum* indicates host plasticity and adaptive potential that may facilitate host range expansion (Yeh *et al.* 2021). On one hand, infection of *A. houstonianum* may reduce weed vigor and potentially alter competitive interactions within invaded plant communities. On the other hand, survival of the pathogen on multiple hosts may stabilize local populations and serve as inoculum reservoirs (Singh *et al.* 2023). This may enable the fungus to bridge the seasonal gaps in host availability and persist across crop rotations as well as geographic ranges (Thines *et al.* 2023).

A recent revision of the checklist of powdery mildew in Nepal (Adhikari 2022) did not include this pathogen on *A. houstonianum*. To the best of our knowledge and based on the available literature, this represents the first record of powdery mildew disease on this weed in Nepal. This finding expands the known host range of *Podosphaera* and contributes to the understanding of powdery mildew diversity in the region.

The detection of *Podosphaera* on *A. houstonianum* in Nepal raises two practical concerns. First, the survival of pathogen at the landscape level may complicate crop protection strategies. The genus *Podosphaera* is well known for its ability to survive in diverse ecological niches, including wild hosts, weeds, ornamentals, and volunteer plants, which can act as inoculum reservoirs (Amano 1986; Thines *et al.* 2023). Second, invasive plants nearby agrosystems require regular monitoring for disease management (Thite *et al.* 2017), as they may serve as inoculum reservoir (Singh *et al.* 2023). To manage these potential risks, efforts should focus on molecular confirmation of the pathogen through DNA sequencing (Polonio *et al.* 2019) and systematic surveys of both the pathogen and host plants across different habitats.

CONCLUSION

This study reported the first record of powdery mildew disease caused by *Podosphaera* sp. on *Ageratum houstonianum* in Nepal. The micromorphological characteristics are consistent with *Podosphaera xanthii* sensu lato, for which molecular confirmation is recommended. *Ageratum houstonianum* is recognized globally as one of the most prevalent invasive plant species, commonly found along roadsides and crop field margins. *Podosphaera* sp. may have potential as a biocontrol agent for controlling invasive *A. houstonianum*; however, the host plant may also serve as inoculum reservoir, linking wild and crop hosts and bridging seasonal gaps in host availability. Therefore, integrated monitoring and weed disease management strategies are recommended to reduce potential risk to susceptible crops.

ACKNOWLEDGMENTS

The authors express our cordial thanks to Prof. Dr. Uwe Braun, (Martin Luther University, Department of Biology, Halle (Saale), Germany) for his valuable suggestions and assistance in locating relevant literatures that supported pathogen identification. The authors also thank Mrs. Pratikshya Chalise, Research Officer at the National Herbarium and Plant Laboratory (KATH), Lalitpur, Nepal for her assistance in identifying the host plant. We are grateful to Mr. Yam Prasad Pokharel, Director General of the Forest Research and Training Centre (FRTC), Nepal for providing laboratory facilities.

REFERENCES

Adhikari MK. 2022. Revised checklist of powdery mildews (Fungi: Erysiphales) from Nepal. J Pl Reso 20(1): 1–13. DOI: 10.3126/bdpr.v20i01.56505

Amano K. 1986. Host range and geographical distribution of the powdery mildew fungi. Tokyo (JP): Japan Scientific Societies Press. p. 67–73.

Aumentado HDR, Guerrero JJG, Balendres MAO. 2023. Powdery mildew in Southeast Asia: Host range, impact, and sources of resistance. Technol Agron 3:9. DOI: 10.48130/TIA-2023-0009

Baiswar P, Chandra S, Ngachan SV. 2008. First report of powdery mildew of *Ageratum houstonianum* in India. Australas Plant Dis Notes 3(1):48–49. DOI: 10.1007/BF03211235

Bhatta R, Sharma P, Pal P. 2022. Clinical evaluation of *Ageratum houstonianum* Mill intoxicated goats. JAFU 5(1):277–283. DOI: 10.3126/jafu.v5i1.48475

Bose R, Bansal N, Thakur O, Pandey S. 2025. First report of *Podosphaera xanthii* infecting *Ageratum houstonianum* in India with taxonomic clarification from *Podosphaera* fusca. Physiol Mol Plant Pathol 140:102869. DOI: 10.1016/j.pmpp.2025.102869

Braun U, Cook RTA. 2012. Taxonomic manual of Erysiphales (powdery mildews). CBS Biodiversity series, 11. Utrecht (NL): CBS-KNAW Fungal Biodiversity Centre.

[CABI] Centre for Agriculture and Bioscience International. 2022. CABI Compendium, CABI International, *Ageratum houstonianum* (Blue billy goat weed). DOI: 10.1079/cabicompendium.3573

[CAES] The Connecticut Agricultural Experiment Station. 2022. *Ageratum*. [Internet]. [Accessed on 13 April 2024]. Available from: https://portal.ct.gov/caes/plant-pest-handbook/ppha/ageratum-ageratum

Choi IY, Abasova L, Choi JH, Lee CK, Shin HD. 2022. Morphological and molecular characterization of *Podosphaera* powdery mildew on *Fatoua villosa* in Korea. Kor J Mycol 50(3):243–248. DOI: 10.4489/KJM.20220025

Johnson MF. 1971. A monograph of the genus *Ageratum* L. (Compositae-Eupatorieae). Ann Missouri Bot Gard 58:6–88. DOI: 10.2307/2394925

Larone DH. 1995. Medically important fungi: A guide to identification. Third edition. Washington, DC (US): ASM Press.

Meeboon J, Kokaew J, Takamatsu S. 2018. Notes on powdery mildews (Erysiphales) in Thailand *V. Golovinomyces*. Trop Plant Pathol 43:202–217. DOI: 10.1007/s40858-017-0201-1

Mukhtar I, Khokhar I, Mushtaq S. 2013. New record of *Podosphaera xanthii* on *Ageratum conyzoides* L. Pakistan. Pak J Weed Sci Res 19(4):475–479.

Mukhtar I, van Peer AF. 2017. First report of *Podosphaera xanthii* causing powdery mildew on *Ageratum conyzoides* in China. Plant Dis 101(8):1553–1553. DOI: 10.1094/PDIS-03-17-0448-PDN

Nadeem H, Akhter G, Khan TA. 2018. Studies on powdery mildew disease caused by *Podosphaera xanthii* on *Ageratum conyzoides*: A new report of Telomorph of *P. xanthii*. Ann Plant Prot Sci 26(1):107–112. DOI: 10.5958/0974-0163.2018.00024.1

Pal PB, Singh DK, Stegelmeier BL. 2011. Buffalo calves intoxicated with *Ageratum houstonianum* Mill. In: Riet-Correa F, Pfister J, Schild AL, Wierenga T (Editors), Poisoning by plants, mycotoxins and related toxins. Wallingford (UK): Centre for Agriculture and Bioscience International (CABI). p. 186–189. DOI: 10.1079/9781845938338.0186

Panstruga R. 2003. Establishing compatibility between plants and obligate biotrophic pathogens. Curr Opin Plant Biol 6(4):320–326. DOI: 10.1016/s1369-5266(03)00043-8

Pisani C, Patel PC, Rosskopf EN, Abbasi M, Aime MC. 2019. First report of downy mildew caused by *Plasmopara halstedii* on *Ageratum houstonianum* in the United States. Plant Dis 103(11):2968–2968. DOI: 10.1094/PDIS-06-19-1331-PDN

Polonio Á, Seoane P, Claros MG, Pérez-García A. 2019. The haustorial transcriptome of the cucurbit pathogen *Podosphaera xanthii* reveals new insights into the biotrophy and pathogenesis of powdery mildew fungi. BMC Genomics 20(1):543. DOI: 10.1186/s12864-019-5938-0

Reeves ER, Henson MS, Sharpe SR, Meadows IM. 2022. Evaluation of annual and herbaceous perennial plants for susceptibility to *Phytophthora* root and crown rot in the Southeastern United States. J Environ Hortic 40(4):154–163. DOI: 10.24266/2573-5586-40.4.154

Shrestha BB, Joshi S, Bisht N, Yi S, Kotru R, Chaudhary RP, Wu N. 2018. Inventory and impact assessment of invasive alien plant species in Kailash Sacred Landscape. ICIMOD Working Paper 2018/2. Kathmandu (NP): International Centre for Integrated Mountain Development (ICIMOD).

Shrestha BB, Shrestha UB, Sharma KP, Thapa-Parajuli RB, Devkota A, Siwakoti M. 2019. Community perception and prioritization of invasive alien plants in Chitwan-Annapurna Landscape, Nepal. J Environ Manage 229:38–47. DOI: 10.1016/j.jenvman.2018.06.034

Singh PK, Vishwakarma RC, Kaur J, Singh R. 2023. Growth and survival of plant pathogens. In: Mishra RC, Singh R (Editors), Principles of Plant Pathology. Chapter 4. Noida (IN): BlueRoseOne Publisher. p. 72–88.

Strickland DA, Hodge KT, Cox KD. 2021. An examination of apple powdery mildew and the biology of *Podosphaera leucotricha* from past to present. Plant Health Prog 22(4):421–432. DOI: 10.1094/PHP-03-21-0064-RV

Thines M, Seebens H, Aime MC, Shivas RG, Kiss L, Essl F, Schertler A. 2023. Host switching and geographic expansions in (hemi) biotrophic plant pathogens. In: Pöggeler S, James T (Editors), Evolution of fungi and fungal-like organisms. Cham (CH): Springer International Publishing. p. 123–148. DOI: 10.1007/978-3-031-29199-9_6

Thite SV, Kore BA, Camacho-Tapia M, Tovar-Pedraza JM. 2017. First report of *Podosphaera xanthii* causing powdery mildew on *Ageratum conyzoides* in India. J Plant Pathol 99(2):533–543.

Yeh YW, Wu TY, Wen HL, Jair HW, Lee MZ, Kirschner R. 2021. Host plants of the powdery mildew fungus *Podosphaera xanthii* in Taiwan. Trop Plant Pathol 46(1):44–61. DOI: 10.1007/s40858-020-00393-2