NUSANTARA BIOSCIENCE
Vol. 9, No. 1, pp. 52-56
February 2017

ISSN: 2087-3948
E-ISSN: 2087-3956
DOI: 10.13057/nusbiosci/n090109

Short Communication: Some additions to powdery mildews (Erysiphales: Fungi) of Northwestern Himalayas

AJAY KUMAR GAUTAM[1,♥], SHUBHI AVASTHI[2]

[1]School of Agriculture, Faculty of Science, Abhilashi University. Mandi, Himachal Pradesh-175028, India. Tel.: +91-9459923654,
[♥]email: a2gautam2006@gmail.com
[2]Department of Botany, Abhilashi Institute of Life Sciences. Mandi, Himachal Pradesh-175008, India

Manuscript received: 12 May 2016. Revision accepted: 16 January 2017.

Abstract. *Gautam AK, Avasthi S. 2017. Short Communication: Some additions to powdery mildews (Erysiphales: Fungi) of Northwestern Himalayas. Nusantara Bioscience 9: 52-56.* During the regular mycological collections, between October to December 2015 in North-West Himalayas of Himachal Pradesh, four powdery mildews parasitic on higher plants were gathered. After study they were found to be *Pseudoidium cryptolepidis* on *Cryptolepis buchanani, Erysiphe trifoliorum* on *Trifolium repentis, Podosphaera xanthii* on *Coreopsis lanceolata* and *Podosphaera euphorbiae-hirtae* on *Euphorbia hirta*. All the powdery mildew fungi are additions to Himachal Pradesh as well as north-west Himalayas.

Keywords: Erysiphales, higher plants, Himachal Pradesh, India

INTRODUCTION

Powdery mildews are obligate and biotropic fungal parasites responsible to infect a variety of hosts such as, agricultural crops, vegetables, trees, herbs, shrubs, grasses, many ornamental plants and even weeds also. These fungi are appeared as white powder on infected surfaces and grows well in environments with high humidity and moderate temperatures (Huang 2000), such favorable conditions are well established in Himachal Pradesh, India. Many researchers worked a lot and still in continuation on powdery mildew fungi of the North Western Himalayas including Himachal Pradesh, but Paul and Thakur (2006) carried out a comprehensive study and compiled it in the form of a monograph "Indian *Erysiphaceae*". It is estimated that about 100 species of powdery mildews belonging to genera *Arthrocladiella*, *Blumeria*, *Erysiphe*, *Farmanomyces*, *Leveillula, Microsphaera*, *Oidopsis*, *Oidium*, *Phyllactinia*, *Pleochaeta*, *Podosphaera*, *Sphaerotheca*, *Uncinula* and *Uncinuliella* (Jamaluddin et al. 2004; Paul and Thakur 2006, Hosagoudar and Agarwal 2009) are reported so far from Himachal Pradesh.

This paper is in continuation with our previous studies on some powdery mildews from Himachal Pradesh, India (Gautam 2014, 2015). During the routine mycological surveys in the district Mandi of Himachal Pradesh, some powdery mildew were found infecting different species of higher plants viz.: *Pseudoidium cryptolepidis* on *Cryptolepis buchanani, Erysiphe trifoliorum* on *Trifolium repentis*, *Podosphaera xanthii Coreopsis lanceolata* and *Podosphaera euphorbiae-hirtae* on *Euphorbiae-hirta*. The literature consulted (Bilgrami et al. 1991; Jamaluddin et al. 2004; Paul and Thakur 2006; Hosagoudar and Agarwal 2009; Braun and Cook 2012; Gautam 2014, 2015), revealed that no record of these fungi were from Himachal Pradesh. These are illustrated and described here in this study.

MATERIALS AND METHODS

Sample collection

The samples were collected during the phytopathological survey of the Mandi District of Himachal Pradesh, India in the year 2015. Mandi, is a well-known region of Himachal Pradesh and popular for its fertile land, plain and hilly regions.

The infected plant parts were dried between sheets of blotting paper and preserved for further studies. The host plants were identified by matching the collections with herbarium and consulting botanists. The specimens are deposited at Abhilashi University (AUMH) Mandi, Himachal Pradesh, India for further reference.

Morphological examinations

The white mycelium on infected leaves were examined primarily with a hand-lens and then with a dissecting microscope to illustrate the disease symptoms in detail. A piece of clear adhesive tape was placed on infected leaves, stripped off and then placed on a microscopic slide with one drop of clear distilled water. The microscopic observations were made under oil immersion by standard light microscopy to note down characters of mycelium (epiphyllous, hypophyllous or amphigenous; color; density), conidia (single or in chains; shape, size, surface), conidiophores (size, shape and size of the foot-cells;

number, size and arrangement of the following cells) and appressoria (shape). Camera Lucida drawings were also prepared to support the final confirmation of fungi. An Olympus light microscope was used to examine fungal structures. Standard literature (Paul and Thakur 2006; Hosagoudar and Agarwal 2009; Braun and Cook 2012, Jamaluddin et al. 2004) was consulted for identification. For name of powdery mildew MycoBank (www.mycobank.org) and Species Fungorum (www.speciesfungorum.org) were consulted.

RESULTS AND DISCUSSION

Four powdery mildews collected are illustrated and described here along with the discussion about their taxonomic position.

Enumeration of the species

Pseudoidium cryptolepidis

Pseudoidium cryptolepidis (Hosag., Vijay, Udaiyan & Siddappa) U. Braun & R. T. A. Cook, *Taxonomic Manual of the Erysiphales (Powdery Mildews)* Biodiversity Series 11: 604 (2012). Figures 1.A-B.

= *Oidium cryptolepidis* Hosag., Vijay, Udaiyan & Manian, *New Botanist* 18(3-4): 241, 1991.

Material examined: Parasitic on leaf surfaces of *Cryptolepis buchanani* Roem & Schult., Tanda, Mandi, 760 meters (2,495 ft), Himachal Pradesh, India, 4 November 2015, Gautam, AUMH 1030.

Mycelium white, mostly epigenous, superficial, effuse or in irregular patches, and later covering the whole leaf surface; hyphae substraight to wavy, branched, 2.65-4.3µm wide; moderately lobed to multilobed hyphal appressoria, solitary or in opposite pairs, 4.4-6.6µm in size; conidiophores arising from the upper part of running hyphae or mother cells, erect, variable in length, up to 110µm long, wide; foot-cells straight, cylindrical, very slightly flexuous and bulbous at the base, about 12.1-40.7× 4.5-7µm long, followed by 1-2 shorter to longer cells, forming conidia singly; conidia vacuolated, ellipsoid to doliiform, cylindrical, 23.1-35.2×11-14.3µm. No chasmothecium was observed.

Distribution: The fungus has been reported only from Tamil Nadu (India), but no report from any other part of the country (Paul and Thakur 2006; Hosagoudar and Agarwal 2009).

Comments: The powdery mildew on *Cryptolepis buchanani* caused by *Pseudoidium cryptolepidis* has recognised as *Oidium cryptolepidi* on the basis of anamorphic characters of mycelium, well-developed lobed to multilobed hyphal appressoria and swollen basal cell of conidiophore and without distinct fibrosin bodies (Paul and Thakur 2006; Hosagoudar and Agarwal 2009). However, Braun and Cook (2012) revised this fungus as *Pseudoidium cryptolepidi*, due to at least partly lobed appressoria, the width of the conidiophores and conidia formed singly. The fungus have been reported only form Tamil Nadu (India), but no report from any other part of the country (Paul and Thakur 2006; Hosagoudar and Agarwal 2009).

Erysiphe trifoliorum

Erysiphe trifoliorum (Wallr.) U. Braun, *Mycotaxon* 112: 175, 2010. Figures 2.A-B.

≡ *Alphitomorpha trifoliorum* Wallr., *Ann. Wetterauischen Ges. Gesammte Naturk.*, N.F., 4: 238, 1819.

Material examined: Parasitic on leaf surfaces of *Trifolium repentis* L., Tanda, Mandi, 760 meters (2,495 ft), Himachal Pradesh, India, 26 October 2015, Gautam, AUMH 1031.

Mycelium white, amphigenous, effuse or in patches, later covering the whole leaf surface, persistent or evanescent; hyphae branched, 2.75-4.1µm wide; moderately lobed to multilobed hyphal appressoria, solitary or in opposite pairs, 3.85-7.1µm in size; conidiophores arising from the upper part of running hyphae or mother cells, erect, up to 110µm long, wide; foot-cells straight, cylindrical, sometimes very slightly flexuous, measuring about 12.1-40.3× 4.4-7.2µm, followed by (1-)2(-4) shorter to or cells of about the same length, forming conidia singly; conidia ellipsoid to doliiform, about 18.7-36.3×12.1-16.5µm; germ tubes variable, terminal or almost so, long, 0.25-4.5 µm (median 1-1.25 µm). No chasmothecium was observed.

Distribution: *Erysiphe trifoliorum* showed a wide host range namely, *Acacia*, *Albizia*, *Amorpha*, *Anthyllis*, *Chamaecytisus*, *Coronilla*, *Cytisus*, *Dorycnium*, *Genista*, *Gueldenstaedtia*, *Hippocrepis*, *Lathyrus*, *Lembotropis*, *Lotus*, *Melilotus*, *Onobrychis*, *Ononis*, *Psoralea*, *Sarothamnus*, *Scorpiurus*, *Securigera*, *Tephrosia*, *Tetragonolobus*, *Trifolium*, *Trigonella*, *Wisteria* from Africa, America, Australia, New Zealand and Asia.

Comments: *Trifolium* sp. is parasitized by many powdery mildew fungi like *Microsphaera trifolii* (Grev.) Braun, *Microsphaera trifolii*, var. *trifolii*, *Erysiphe pisi* DC. and *Uncinuliella flexuosa* (Peck.) Braun. Two powdery mildew namely. *Microsphaera trifolii* (Grev.) Braun, *M. trifolii*, var. *Trifolii* are synonyms for *Erysiphe trifoliorum.* The present fungus differs from *Erysiphe pisi* where conidia are ellipsoid-cylindrical and bigger (25-55 × 10-22 µm) in size. *Uncinuliella flexuosa*, another powdery mildew fungus found on *Trifolium* sp. showed close similarity with present species in anamorphic structures, but found variable in size of conidiophores (60-150 µm long). Another point of differentiation was, uncinuloid appendages on *chasmothecia* in *Uncinuliella flexuosa*, however, no chasmothecium was observed in *Erysiphe trifoliorum*.

Podosphaera xanthii

Podosphaera xanthii (Castagne) U. Braun & Shishkoff, *Schlechtendalia* 4: 31, 2000. Figures 3.A-B.

≡ *Erysiphe xanthii* Castagne, *Cat. Pl. Marseille*: 188, 1845.

Material examined: Parasitic on leaf surfaces of *Coreopsis lanceolata* Roem & Schult., Tanda, Mandi, 760

meters (2,495 ft), Himachal Pradesh, India, 16 November 2015, Gautam, AUMH 1032.

Mycelium white, amphigenous and on stems and inflorescences, superficial, thin to dense, effuse or in irregular patches, and later covering the whole leaf surface; hyphae thin-walled, smooth or almost so, 4.3-6.6 µm wide; indistinct to slightly nipple-shaped hyphal appressoria, solitary, 4.2-6.6µm in size; conidiophores arising from the upper surface of hyphal mother cells, erect, foot-cells, cylindrical, measuring 60-110× 7-11 µm, slightly constricted at the basal septum or slightly swollen at the very base followed by 1-3(-4) shorter cells, forming catenescent conidia, in long chains; conidia ellipsoid-ovoid to doliiform, 27.5-32.5 × 16.5-22 µm; germ tubes ± lateral, simple to forked, short (*brevitubus* subtype of the *Fibroidium* type). No chasmothecium was observed.

Distribution: *Podosphaera xanthi*, is reported to infect numerous hosts of the family *Asteraceae*, *Balsaminaceae*, *Caricaceae*, *Cucurbitaceae*, *Fabaceae*, *Gesneriaceae*, *Malvaceae*, *Medusagynaceae*, *Polemoniaceae*, *Scrophulariaceae*, *Solanaceae*, *Verbenaceae* from America, Australia, Africa, Europe, New Zealand and Asia. In India the fungus has been reported only form West Bengal (Baiswar et al. 2010), but no report from any other part of the country.

Comments: Previously, *Golovinomyces cichoracearum* (Glawe et al. 2006; Seijo et al. 2006), *Podosphaera fusca* (Garibaldi et al. 2007; Baiswar et al. 2010); *Erysiphe arcuata* (Lee 2012); *Golovinomyces spadiceus* (Dugan 2013) and *Leveillula taurica* (Braun and Cook 2012) have been reported on *Coreopsis*. The present species differs from above powdery mildews in having slightly constricted basal septum or slightly swollen at the very base conidiophores and size of conidia.

Podosphaera euphorbiae-hirtae

Podosphaera euphorbiae-hirtae (U. Braun & Somani) U. Braun & S. Takam., *Schlechtendalia* 4: 28, 2000. Figures 4.A-B.

≡ *Sphaerotheca euphorbiae-hirtae* U. Braun & Somani, *Mycotaxon* 25: 263, 1986.

= *Oidium euphorbiae-hirtae* J.M. Yen, *Rev. Mycol.* (Paris) 31(4): 296, 1966.

= *O. pedilanthi* J.M. Yen, *Cah. Pacifique* 11: 104, 1967.

Material examined: Parasitic on both leaf surfaces of *Euphorbia hirta* L., Tanda, Mandi, 760 meters (2,495 ft), Himachal Pradesh, India, 16 November 2015, Gautam, AUMH 1033.

Mycelium white, amphigenous, on leaves and stems, effuse or in patches, later on covers whole leaf surfaces, usually persistent; hyphae hyaline, persistent thin-walled, rather straight and coarse, about 4.4-10 µm wide; hyphal appressoria simple, nipple-shaped, solitary; conidiophores arising from the upper surface of superficial hyphae, erect, straight, 120-250 µm long, foot-cells cylindrical, 35.5-90 × 10-15 µm, followed by 1-3 shorter cells, forming catenescent conidia, mostly 3-8 conidia per chain; *conidia* ellipsoid-ovoid to doliiform, 22-37.5 × 12.5-25 µm. No chasmothecium was observed.

Distribution: This fungus is reported from China, Taiwan, India, Japan, Malaysia, Singapore, Sri Lanka on a wide range of plant hosts. In India, it is reported from Rajasthan (Majumdar et al. 2007) and from Maharashtra (Pawar and Patil 2011). However, no report from Himachal Pradesh, India.

Comments: This powdery mildew fungus is reported on other plant hosts like *Euphorbia titymaloides* and *Acalypha australis*.

ACKNOWLEDGEMENTS

Authors are thankful to Heads of their respective organizations for providing laboratory facilities required during the research work and valuable support throughout the study.

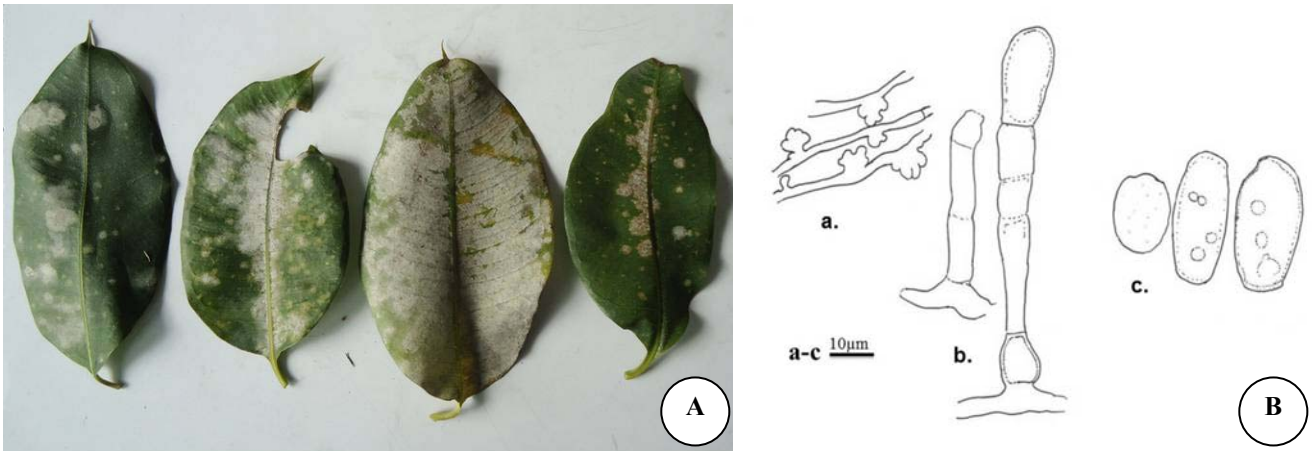

Figure 1. A. Powdery mildew on *Cryptolepis buchanani*. B. *Pseudoidium cryptolepidi* (anamorphic stage). (a) Hyphae with appressoria, (b) Conidiophores with swollen foot cell followed by 1-2 shorter to longer cells bearing single conidia, (c) Conidia

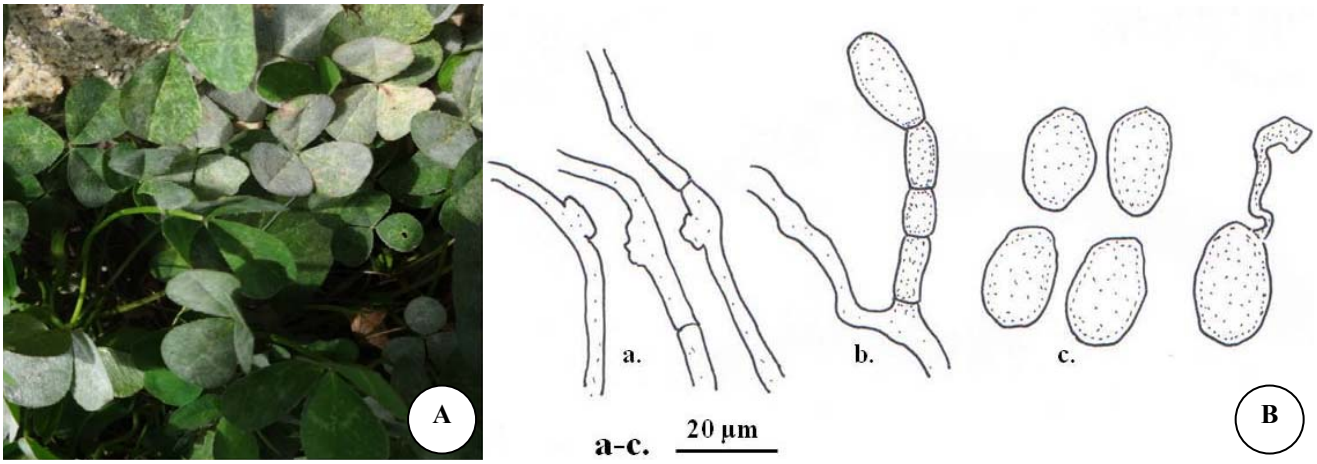

Figure 2. A. Powdery mildew on *Trifolium repentis.* B. *Erysiphe trifoliorum* (anamorphic stage). (a) Hyphae with appressoria, (b) Conidiophores with foot cell bearing single conidia, (c) Conidia with germ tube

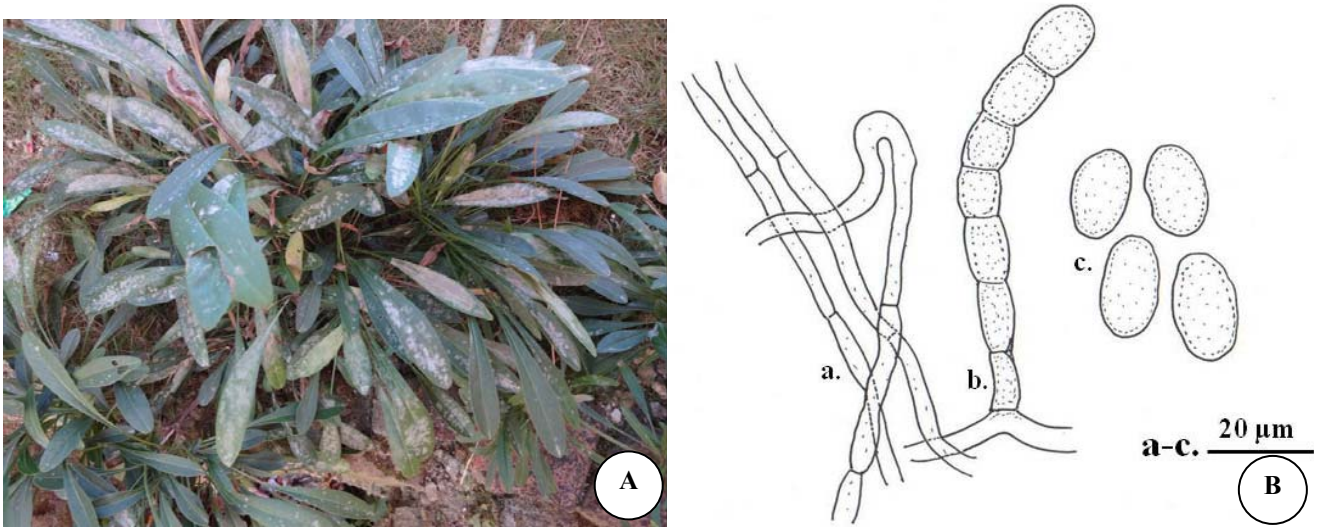

Figure 3. A. Powdery mildew on *Coreopsis lanceolata*. B. *Podosphaera xanthii* (anamorphic stage). (a) Hyphae, (b) Conidiophores with foot cell bearing chain of conidia, (c) Conidia

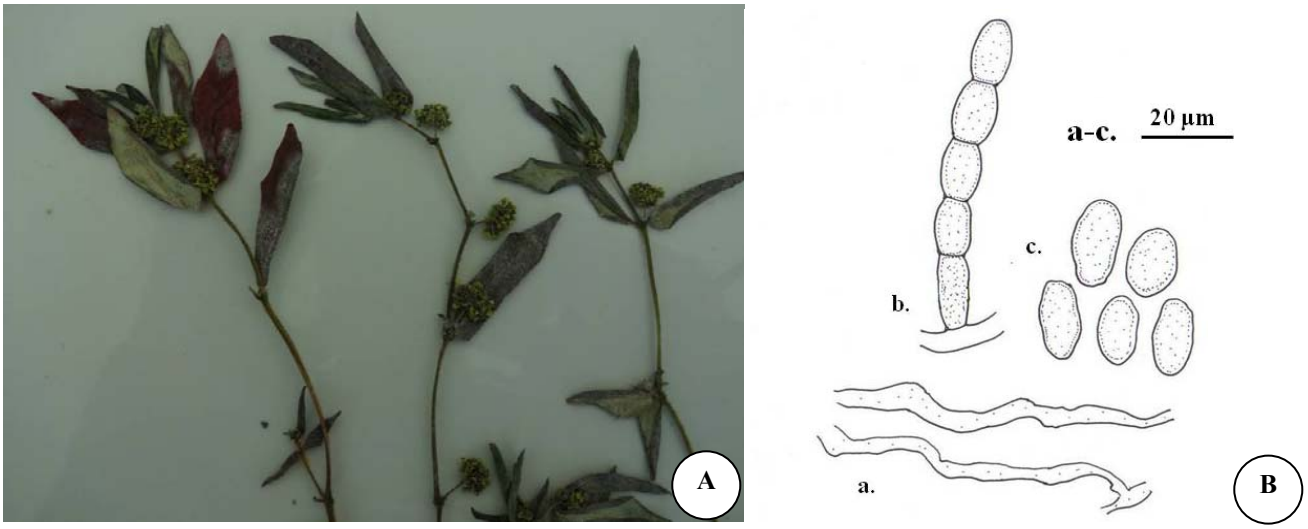

Figure 4. A. Powdery mildew on *Euphorbia hirta.* B. *Podosphaera euphorbiae-hirtae* (anamorphic stage). (a) Hyphae with simple appressoria, (b) Conidiophores with foot cell bearing chain of conidia, (c) Conidia

REFERENCES

Baiswar P, Chandra S, Bag TK, Ngachan SV. 2010. First report of powdery mildew caused by anamorphic *Podosphaera* sp. on *Coreopsis* sp. in India. Austr Pl Dis Note 5: 90-92.

Bilgrami KS, Jamaluddin S, Rizwi MA. 1991. Fungi of India-List and references. Today and Tomorrow Printers & Publishers, New Delhi, India.

Jamaluddin, Goswami MG, Ojha BM. 2004. Fungi of India 1989-2001, Scientific Publishers, Jodhpur, India.

Braun U, Cook RTA. 2012. Taxonomic manual of the Erysiphales (Powdery Mildews). Fungal Biodiversity Centre (CBS Biodiversity Series No. 11), Utrecht.

Dugan FM. 2013. *Golovinomyces spadiceus* causing powdery mildew on *Coreopsis hybrid* 'Full Moon' (Heliantheae, Asteraceae) in Washington State. North Amer Fungi 8: 1-3.

Garibaldi A, Bertetti D, Gullino ML. 2007. First report of powdery mildew caused by *Podosphaera fusca* on *Coreopsis lanceolata* in Italy. Plant Dis 91: 1203.

Gautam AK. 2014. Powdery mildew of *Celtis australis*: a report from Himachal Pradesh, India. Plant Pathol Quarant 4: 14-16.

Gautam AK. 2015. Studies on some powdery mildews from Himachal Pradesh, India. Australasian Mycologist 32:10-13.

Glawe DA, Grove GG, Nelson M. 2006. First report of powdery mildew of *Coreopsis* species caused by *Golovinomyces cichoracearum* in the Pacific Northwest. Plant Health Progress. DOI:10.1094/PHP-2006-0405-01-BR.

Hosagoudar VB, Agarwal DK. 2009. Powdery mildews of India: Check list. Associated Publishing Company, New Delhi.

Huang XQ, Hsam SLK, Zeller FJ, Wenzel G, Mohler V. 2000. Molecular mapping of the wheat powdery mildew resistance gene Pm24 and marker validation for molecular breeding. Theor Appl Genet 101: 407-414.

Lee HB. 2012. First report of powdery mildew caused by *Erysiphe arcuata* on Lanceleaf Coreopsis (*Coreopsis lanceolata*) in Korea. Plant Dis 96: 1827.

Majumdar VL, Ahir RR, Verma OP. 2007. Anamorphic state of powdery mildew on some medicinal plants in Rajasthan. Plant Dis Res 22: 95.

Paul YS, Thakur VK. 2006. Indian Erysiphaceae. Scientific Publishers, Jodhpur.

Pawar VP, Patil VA. 2011. Occurrence of powdery mildew on some wild plants from Khandesh region of Maharashtra state. Recent Res Sci Technol 3: 94-95.

Seijo TE, Czarnecki D, Dheng Z, Peres NA. 2006. First report of powdery mildew caused by *Golovinomyces cichoracearum* on *Coreopsis leavenworthii*. Plant Health Progress DOI 10.1094/PHP-2006-1214-01-BR.