Diseases Caused by Fungi and Fungus-Like Organisms

First Report of Powdery Mildew Caused by *Golovinomyces ambrosiae* on *Verbena bonariensis* in Korea

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Verbena bonariensis L., named purple-top vervain or Argentinian vervain, is native to tropical South America. It is cultivated worldwide as an ornamental plant. During summer and autumn of 2020, over 50% of the leaves of *V. bonariensis* were found infected with powdery mildew in a flower garden in Seoul (37°35'19"N, 127°01'07"E), Korea. White, superficial mycelia developed initially on the leaves and subsequently covered surfaces of leaves and stems, resulting in leaf discoloration, early defoliation, and shoot distortion. Heavily infected plants lost ornamental value. A representative voucher specimen was deposited in the Korea University herbarium (KUS-F32168). Morphological characterization and measurements of conidiophores and conidia were carried out using fresh samples. Microscopic observation showed that appressoria on the superficial hypha were nipple-shaped, but rarely found. Conidiophores ($n = 30$) were cylindrical, 110 to 220 $\times$ 10 to 12 μ m, and produced 2 to 5 immature conidia in chains with a sinuate outline, followed by 2 to 3 short cells. Foot-cells of conidiophores were straight, cylindrical, and 46 to 90 μ m long. Conidia ($n = 30$) were hyaline, ellipsoid to doliform, 28 to 40 $\times$ 18 to 24 μ m with a length/width ratio of 1.3 to 2.0, and contained small oil-like drops, but without distinct fibrosin bodies. Primary conidia were apically rounded and subtruncate at the base. Germ tubes were produced at

perihilar position of the conidia. Chasmothecia were not observed. These morphological characteristics were typical of the conidial stage of the genus *Golovinomyces* (Braun and Cook 2012; Qiu et al. 2020). To identify the fungus, rDNA was extracted from the voucher sample. PCR products were amplified using the primer pair ITS1F/PM6 for internal transcribed spacer (ITS), and PM3/TW14 for the large subunit (LSU) of the rDNA (Takamatsu and Kano 2001). The resulting sequences were registered to GenBank (MW599742 for ITS, and MW599743 for LSU). Using BLASTn search of GenBank, sequences showed 100% identity for ITS and LSU with *G. ambrosiae* (MT355557, KX987303, and MH078047 for ITS, and AB769427 and AB769426 for LSU), respectively. Thus, based on morphology and molecular analysis, the isolate on *V. bonariensis* in Korea was identified as *G. ambrosiae* (Schwein.) U. Braun & R.T.A. Cook. Pathogenicity tests were carried out by touching an infected leaf onto healthy leaves of disease-free pot-grown plants using a replication of five plants, with five noninoculated plants used as controls. After 7 days, typical powdery mildew colonies started to appear on the inoculated leaves. The fungus on inoculated leaves was morphologically identical to that originally observed in the field. All noninoculated control leaves remained symptomless. There have been many reports of *Golovinomyces* powdery mildews including *G. cichoracearum* s.lat., *G. longipes*, *G. monardae*, *G. orontii* s.lat., and *G. verbenae* (Farr and Rossman 2021). In China, *G. verbenae* was recorded on *V. phlogiflora* (Liu et al. 2006). *Golovinomyces* powdery mildew has not been reported on *Verbena* spp. in Korea. Powdery mildew has been reported on *V. bonariensis* in California, but identity of the causal agent had not been reported. To our knowledge, this is the first report on the identity of the powdery mildew caused by *G. ambrosiae* on *V. bonariensis* in Korea. Since heavily infected plants lost ornamental value, appropriate control measures should be developed.

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