Diseases Caused by Fungi and Fungus-Like Organisms

First Report of *Podosphaera macularis* Causing Hop (*Humulus lupulus*) Powdery Mildew in Brazil

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The hop (*Humulus lupulus* L.) is a dioecious perennial climbing plant grown commercially worldwide. Wild hops are widely distributed throughout the Northern Hemisphere, Europe, Asia, and North America (Neve 1991). In the Southern Hemisphere, some of the leading hop-producing countries include South Africa, Australia, and New Zealand. Brazil began hop production less than 5 years ago. In January 2019, amphigenous white powdery circular fungal colonies were observed on the leaves and stems of hop plants (cultivar 'Chinook') within a 900-m² hop garden in Lages municipality, Santa Catarina State, southern Brazil. The disease was present on almost 100% of Chinook cultivar plants, and diseased foliage was collected to identify the pathogen and used to inoculate healthy plants. Hop powdery mildew lesions with hyaline and septate mycelium with chains of unicellular conidia ($n = 100$), hyaline, barrel-shaped, mean of length/width $\pm$ standard deviation $25 \text{ to } 27 \times 13 \text{ to } 18 \mu\text{m} \pm 0.980$, with fibrosin bodies, and conidiophores erect with cylindrical foot cells, were visible within 10 days. The causal agent was identified as *Podosphaera macularis* (Wallr.:Fr.) Lind (synonym *S. humuli* [DC.] Burrill) on the basis of conidial shape, size, and host range (Braun 1987; Mahaffee et al. 2009; Royle 1978), complemented with the present molecular analysis. Chasmothecia have not been observed in the field to date. A conidial suspension of 200 ml at concentration of 1.4×10^5 was mixed with 5 μl of Tween 20 for the pathogenicity assay. Ten plants of

9-month-old hop (cv. Chinook) were inoculated with 5 ml of the conidial suspension using a manual spray. The control plot was only sprayed with water. The inoculated plants were maintained at $22 \pm 1^\circ\text{C}$ with a 12-h photoperiod and 65% relative humidity. White mycelia were visible first on the adaxial leaf surfaces of the inoculated younger leaves after 10 days, and the disease severity reached between 2 and 5%. No symptoms were observed at the control plot. *P. macularis* infected most aerial plant tissues of the inoculated plants and caused losses of approximately 50% of cones. *P. macularis* conidia were collected from the infected leaf tissue with a sterile soft camel-hair brush, and DNA was extracted using a Wizard Genomic DNA extraction kit. The primers ITS1/ITS4 (White et al. 1990) were used to amplify and sequence a fragment of the ITS region. PCR products were subjected to Sanger sequencing to confirm sample species. The resulting 522-bp sequence was deposited into GenBank (accession no. MN630490). BLASTn showed a 99.81% sequence identity with the CT1 isolate of *P. macularis* from *H. lupulus* (MH687414). The presence and identification of *P. macularis* in hop production regions is a new challenge to growers in Brazil. Research related to the knowledge of the disease cycle, epidemiology, and control strategies for the integrated management should be conducted, as there are no registered fungicides for powdery mildew on hop in Brazil. To our knowledge, this is the first report of *P. macularis* in Brazil, as well as in South America.

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