

## Diseases Caused by Fungi and Fungus-Like Organisms

### First Report of *Mucor* Rot Caused by *Mucor circinelloides* on *Gastrodia elata* in China

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*Gastrodia elata* Blume is used as a traditional Chinese herbal medicine and is widely planted throughout China (Zhu et al. 2019). From September to October 2022, *G. elata* tuberous rot occurred in 47 households in Yiliang County, Zhaotong City (27°39'N, 104°16'E), Yunnan Province, China, within a major *G. elata* production area covering 776 ha, with an incidence rate of 10 to 15%. Symptoms manifested as black and brown lesions on the tuber surface, which were concave, soft, and foul-smelling and were surrounded by grayish-brown tissue. Three infected *G. elata* were randomly collected from each household and placed in transparent plastic bags, and pathogen isolation was conducted in a laboratory. Infected *G. elata* tubers were surface sterilized with 0.5% NaOCl for 2 min, rinsed five times with sterile water, and dried. Symptomatic tissues from the margin between necrotic and healthy tissues were cut into 5 × 5-mm pieces, placed onto potato dextrose agar (PDA), and incubated at 28°C in the dark for 3 days. Hyphal tips of fungi growing from the samples were transferred onto new PDA plates and incubated until they produced conidia. Five fungal isolates

(Charliezhao 417, 418, 419, 420, and 421) with the same morphological characteristics were obtained from the samples. Colonies tended to be yellow or light gray and produced sporangiospores that were subglobose, ellipsoid, or irregular, measuring 4.0 to 9.7 × 2.5 to 4.6 μm ( $n = 50$ ). The morphological characteristics of the isolates resembled those of *Mucor circinelloides* (Wagner et al. 2020). Genomic DNA of two representative isolates (Charliezhao 417 and 418) was extracted using the DN14 cetyltrimethylammonium bromide rapid plant genome extraction kit (Aidlab Biotechnologies, Beijing). The ITS and RPB1 genes were amplified by polymerase chain reaction using the primers ITS1/ITS4 (White et al. 1990) and Af/Cf (Matheny et al. 2002), respectively. All sequences were deposited in GenBank (accession nos. OQ612709 and OR028949 for ITS and OQ621439 and OR033135 for RPB1). A BLASTN homology search with the ITS nucleotide sequences showed that they had 99.5 to 99.2% identity with the *M. circinelloides* isolates KR056083 (603 of 606 bp) and KJ588204 (617 of 622 bp), respectively, and the RPB1 sequences had 99.89 to 99.75% identity with the isolates KJ588206 (874 of 875 bp) and KJ588206 (803 of 805 bp), respectively. To fulfill Koch's postulates, five mature, healthy *G. elata* tubers were surface disinfected with 1% NaClO solution for 1 min, rinsed with sterile water, and dried at 25°C for 30 min. A conidial suspension (10<sup>6</sup> spores/ml) collected from the two isolates (Charliezhao 417 and 418) was sprayed onto *G. elata* tubers, whereas the control was treated with distilled water. All *G. elata* tubers were incubated at 25°C with 80% relative humidity. The experiment had five replicates. After 7 days of incubation, there were obvious brown spots on the inoculated tubers; no symptoms were observed on the controls. The pathogen was reisolated from all the inoculated *G. elata* tubers and confirmed as *M. circinelloides* by morphological and molecular analyses, fulfilling Koch's postulates. This is the first report of *M. circinelloides* causing *G. elata* Mucor rot in China. The tubers of *G. elata* are often used in the treatment of headaches, convulsions, and neurodegenerative disorders (Manavalan et al. 2012). Thus, the declining yield of *G. elata* because of persistent obstacles related to continuous cropping and diseases poses a potential threat to the development of the *G. elata* industry.

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