Diseases Caused by Fungi and Fungus-Like Organisms

First Report of Ear Rot of *Chenopodium quinoa* Caused by *Cladosporium cladosporioides* in Shanxi, China

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Chenopodium quinoa Willd., a pseudocereal food crop, has been cultivated for several thousand years in South America (Jacobsen 2003), and has been accepted as a functional food in China and planted with increasing coverage. In November 2019, an ear rot disease was observed on *C. quinoa* in greenhouses on a farm in Yuanping City (38.73° N; 112.7° E). In 2020, about 5 to 50% of plants in greenhouses and fields were infected and yield loss was estimated to be 5 to 30% in Shanxi Province, north China. At first, an olive-green, spot-shaped mildew layer appeared on some glume shells. The color gradually deepened, turning brown to black-brown, and the number of affected glume shells gradually increased, spreading to entire spikelets. Most of the infected spikelets became withered and moldy. Occasionally, a necrotic patch covering the mildew layer appeared on the young stem close to the ear, causing the upper part of the plant to wilt and even die. To identify the causal agent of the disease, fresh spikelets with symptoms of ear rot were collected from diseased plants ($n = 7$). Spores produced by the pathogen were picked with a sterilized inoculation needle in a sterilized airflow hood and were suspended in sterilized deionized water. The dilution plate method was deployed to obtain single-spore cultures on potato dextrose agar (PDA) plates. The colonies ($n = 14$) were round and flat in a powder form, olive green, with folds and depressions in the center, dark green on the underside of the colony, and

forming cracks in the medium. Conidiophores grew from the side of hyphae, smooth or sometimes verruculose, and 51.50 to 127.63×2.91 to $5.35 \mu\text{m}$ ($n = 50$). Ramoconidia had 0 to 1 septa, mostly 2 to 3 conidial scars, and measured 6.51 to 15.73×2.4 to $4.47 \mu\text{m}$ ($n = 50$). Conidia formed in long, branched chains that were readily disarticulating, single-celled, colorless or brown, elliptic or rod-shaped, with blunt round ends, and measured 2.76 to 5.42×1.78 to $3.88 \mu\text{m}$ ($n = 50$). The morphological characteristics of the isolates were consistent with those of *Cladosporium cladosporioides* (Bensch et al. 2012). To further identify the causal agent, the actin (*Act*), translation elongation factor (*TEF-1 α*), and rDNA internal transcribed spacer (ITS) regions of the selected isolate YTC1 were amplified and sequenced. BLASTn analysis showed that *Act* (MW560123), *TEF-1 α* (MW560124), and ITS (MZ674407) of YTC1 were 99 to 100% identical to *C. cladosporioides* (GenBank accession nos. HM148504, HM148515, and HM148527 for ACT sequences; HM148258, HM148269, and HM148281 for *TEF-1 α* sequences; HM148017, HM148028, and HM148040 for ITS sequences). The pathogenicity test was performed by injecting $10 \mu\text{l}$ of conidial suspension (10^7 conidia/ml) into the inoculated ears ($n = 5$), each of which had 8 to 10 spikelets. Treatments without inoculation were the control ($n = 5$), and all the treatments were maintained at 25°C and 90% relative humidity in an incubator. All inoculated ears showed symptoms similar to those observed above after 5 days, but no symptoms were observed on the controls, and *C. cladosporioides* isolates were re-isolated from plants and identified by the morphological and molecular traits described above, thus fulfilling Koch's postulates. *C. cladosporioides* is known to be found on fading and decaying plant material, or as a secondary invader on living plants (Bensch et al. 2012). To the best of our knowledge, this is the first report of *C. cladosporioides* as the causal agent of ear rot of *C. quinoa* in China and perhaps the world. The new disease has impacted the yield and quality of *C. quinoa* and alerted scientists to investigate effective control strategies.

References:

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