Diseases Caused by Fungi and Fungus-Like Organisms

American Ginseng Root Rot Caused by *Fusarium redolens* in China

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American ginseng (*Panax quinquefolium* L.), native to North America, is an important herbal medicine and economic crop. With the increasing market demand, China has become the third largest producer and the largest consumer of American ginseng. However, continuous cropping has become serious problem for production of American ginseng and has led to accumulation of root fungal pathogens and disease occurrence (Zhang et al. 2020). Root rot caused by soil-borne pathogenic fungi, such as *Fusarium* spp., can result in a significant reduction of yield and quality of American ginseng. From 2017 to 2019, investigation of American ginseng root rot was carried out in Liuba County, Shaanxi Province, China. About 20% of American ginseng showed root rot symptoms in newly reclaimed fields, and more than 70% in continuous planted American ginseng fields. Among these diseases, we found plants with red leaves and yellow to yellow-brown lesions on taproots. Lesions mainly appeared on the root surface; however, vascular tissue was not discolored. Fifteen *Fusarium* isolates were obtained by cutting diseased roots into 5 × 5-mm pieces, disinfecting them in 70% ethanol for 1 min, rinsing two to three times in sterile water for 1 min, and plating them on potato dextrose agar supplemented 50 µg/ml of streptomycin sulfate. All isolates were morphologically similar, producing white colonies. Microconidia were oval to cylindrical with zero to one septa and ranged from 6.2 to 10.1 µm long; macroconidia were fusiform to conical with a hooked apical cell and a foot-shaped basal cell, usually one to three septate, ranging from

31.5 to 42.5 µm long. Chlamydospores were observed on carboxymethylcellulose medium. Preliminary data analysis showed that the morphological characteristics of these isolates were consistent with the descriptions of *Fusarium* (Leslie and Summerell 2006). To identify the pathogen, the rDNA internal transcribed spacer (ITS), translation elongation factor 1 alpha (*TEF1*), and RNA polymerase II subunit 1 (*RPB1*) fragments of two randomly selected isolates were amplified and sequenced. BLASTn results of GenBank and *FUSARIUM*-ID databases show the isolates were *Fusarium redolens* (Geiser et al. 2004). Although the ITS sequence (GenBank accession no. MW331695) cannot distinguish *F. redolens* from *F. hostae* (Baayen et al. 2001), combined phylogenetic analysis of the sequence of *TEF1* (MW344286) and *RPB1* (MW344285) clearly showed that the pathogen is *F. redolens*. The pathogenicity of a representative isolate, YP04, was tested on ginseng taproot by in vivo inoculation experiments with three replications, with each replication seven plants. The surface of 2-year-old healthy ginseng taproot was washed and disinfested with 75% alcohol for 1 min, rinsed with sterile water, and dried. The surface was injured with sterilized steel needles for 2.0 mm depth and immersed in 1 × 10⁶/ml spore suspension (sterile water for control plants) for 30 min. The treatment and control plants were planted in 20-cm-diameter flowerpots filled with sterilized forest humus and cultured in a greenhouse at 18 to 23°C under a day/night photoperiod of 14/10 h. Six days after transplanting, the leaves began to turn red. The cortex of the taproot showed yellow-brown lesions, and the vascular tissue turned to light yellow. Fifteen days after transplanting, the aboveground parts of treatment plants began to wilt, and the taproots showed serious rot. The disease incidence was 100%. No symptom of taproot rot was observed in the controls. The pathogen was reisolated from the diseased taproots successfully and identified based on the methods described above, fulfilling the Koch's postulates. To our knowledge, this is the first report of *F. redolens* causing root rot of American ginseng in China.

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