Diseases Caused by Nematodes

First Report of the Cactus Cyst Nematode, *Cactodera cacti*, Infecting *Cereus jamacaru* (Cactaceae) in Brazil

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During a survey in 2018 for plant nematodes associated with roots and soil in cactus cultivation areas in Ceará State (3°44'48" S, 38°34'29" W), cysts were found on the roots of mandacaru, *Cereus jamacaru* DC. This cactus is native to Brazil, can grow to 6 to 10 m tall, and is widely distributed in the Northeast region (Romeiro-Brito et al. 2016), where it is used in construction, in disease remedies, as forage, and as an ornamental plant (Sales et al. 2014). Several cysts, second-stage juveniles (J2), and eggs extracted from the soil and roots using sucrose centrifugation were examined by scanning electron microscopy and light microscopy to determine morphological and morphometric characteristics. Molecular characteristics were determined by DNA extraction from J2 and embryonated eggs using a protocol specific for Heteroderidae (Subbotin et al. 2018). The internal transcribed spacer sequence (ITS) region of the rDNA and D2-D3 regions of the 28S rDNA were amplified using the universal primers TW81 (5'-GTTTCGGTAGGTGAACCTGC-3') and AB28 (5'-ATATGCTTAAGTTCAGCGGGT-3'), and D2A (5'-ACAA GTACCGTGAGGGAAAGTTG-3') and D3B (5'-TCGGAAGGAACCAGC TACTA-3'), respectively. To confirm that mandacaru is a host for *Cactodera cacti*, six plantlets of mandacaru were inoculated with 1,800 eggs of the nematode and kept in a greenhouse at 31 ± 3°C and irrigated daily. Six noninoculated mandacaru plantlets served as a control treatment. Morphometric characteristics of cysts ($n = 35$) were body length, excluding neck, 555.8 ± 87.8 (354.9 to 727.6) µm; body width 392.1 ± 63.4 (297.9 to 553.7) µm; neck length 63.5 ± 25.8 (49.8 to 105.0) µm; length to width ratio 1.4 ± 0.2

(1.0 to 1.8); and vulval cone length 48.4 ± 15.2 (40.7 to 53.6) µm. Cysts had a rough surface, were lemon shaped to rounded, and had a zigzag cuticular pattern with a protruding vulval cone. They were circumfenestrate without under-bridge and bullae but with the presence of vulval denticles. Measurements of J2 ($n = 13$) included body length 511.2 ± 33.7 (452.7 to 551.5) µm; stylet length 28.0 ± 2.8 (25.4 to 34.0) µm; tail length 50.7 ± 5.1 (40.6 to 57.4) µm; tail hyaline region 22.7 ± 2.2 (18.9 to 27.1); with $a = 20.9 \pm 2.2$ (17.7 to 24.3); $b = 5.4 \pm 0.4$ (5.1 to 5.8); $b' = 3.4 \pm 0.4$ (3.1 to 3.9); $c = 10.2 \pm 1.3$ (8.9 to 13.3); and $c' = 3.8 \pm 0.4$ (3.0 to 4.5). The essential morphological characteristics for identification indicated that the species found on *C. jamacaru* was *C. cacti* (Filipjev & Schuurmans-Stekhoven, 1941) Krall & Krall, 1978. The sequences of the studied rDNA regions were submitted to GenBank (ITS: MW562829 and D2-D3 regions of 28S: MW562830). The samples used for molecular analysis showed a high degree of sequence identity (99.59%) with *C. cacti* from China, Iran, and the United States for the ITS region. The identity of the D2-D3 regions of the 28S sequence was 99.54% with *C. cacti* isolates from Germany and 99.41% with isolates from the United States. Phylogenetic analyses were performed using the maximum likelihood method for both individual loci, confirming the species as *C. cacti*. All inoculated mandacaru plantlets showed *C. cacti* cysts on the roots after 60 days, confirming that mandacaru is a host for *C. cacti*. This species was reported in São Paulo State in 2001 associated with ornamental cactus cultivated in pots, but plant species were not identified (Santos et al. 2001). The second report in Brazil was on *Schlumbergera* sp., an ornamental plant (Oliveira et al. 2007). In both studies, the nematode was neither morphologically nor molecularly characterized. *C. cacti* has been commonly associated with cactus worldwide (Esser 1992). It has been reported in association with *C. jamacaru* and was first reported in 2011 in China (Duan et al. 2012). This is the first report of the occurrence of *C. cacti* on *C. jamacaru* in field conditions in Brazil, and its presence in cactus cultivation areas with agricultural importance represents a threat to cactus production in the country.

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