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Disease Notes

First Report of '*Candidatus* Liberibacter solanacearum' on Carrot in Africa

R. Tahzima and **M. Maes**, Institute for Agricultural and Fisheries Research (ILVO), Plant Sciences Unit, Laboratory of Virology, Burg. Van Gansberghelaan, 9820 Merelbeke, Belgium; **E. H. Achbani**, National Institute for Agricultural Research (INRA), Laboratory of Phytobacteriology, Route Hajj Kaddour, Meknès, Morocco; **K. D. Swisher** and **J. E. Munyaneza**, United States Department of Agriculture, Agricultural Research Service, Yakima Agricultural Research Laboratory, 5230 Konnowac Pass Road, Wapato, WA 98951; and **K. De Jonghe**, ILVO, Plant Sciences Unit, Laboratory of Virology, Burg. Van Gansberghelaan, 9820 Merelbeke, Belgium

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In March of 2014, carrot plants (*Daucus carota* L. var. Mascot) exhibiting symptoms of yellowing, purpling, and curling of leaves, proliferation of shoots, formation of hairy secondary roots, general stunting, and plant decline were observed in commercial fields in the Gharb region of Morocco. The symptoms resembled those caused by phytoplasmas, *Spiroplasma citri*, or '*Candidatus* Liberibacter solanacearum' infection (1,2,3). About 30% of the plants in each field were symptomatic and plants were infested with unidentified psyllid nymphs; some psyllids are known vectors of '*Ca*. L. solanacearum.' A total of 10 symptomatic and 2 asymptomatic plants were collected from three fields. Total DNA was extracted from petiole and root tissues of each of the carrots, using the CTAB buffer extraction method (3). The DNA samples were tested for phytoplasmas and spiroplasmas by PCR (3) but neither pathogen was detected in the samples. The DNA extracts were tested for '*Ca*. L. solanacearum' by PCR using specific primer pairs OA2/OI2c, Lso adkF/R, and CL514F/R, to amplify a partial fragment of the 16S rDNA, the adenylate kinase gene, and *rpIJ*/*rpIL*50S rDNA ribosomal protein genes, respectively (1,2,5). DNA samples from all 10 symptomatic carrots yielded specific bands; 1,168 bp for the 16S rDNA fragment, 770 bp for the adk fragment, and 669 bp for rpIJ/rpIL, indicating the presence of 'Ca. L. solanacearum.' No '*Ca*. L. solanacearum' was detected in asymptomatic plants. DNA amplicons of three plant samples (one plant/field) for each primer pair were directly sequenced (Macrogen Inc., Amsterdam). Sequencing results identified two distinct products for the OA2/OI2c primer pair (GenBank Accession Nos. KJ740159 and KJ740160), and BLAST analysis of the 16S rDNA amplicons showed 99 and 100% identity to '*Ca.* L. solanacearum' (KF737346 and HQ454302, respectively). Two different sequences of the *adk* amplicon were obtained (KJ740162 and KJ740163), both of which were 98% identical to '*Ca*. L. solanacearum' (CP002371). Sequencing results also identified two distinct products for the CL514F/R primer pair

(KJ754506 and KJ754507), and BLAST analysis of the 50S rDNA ribosomal protein showed 99 and 100% identity to '*Ca.* L. solanacearum' (KF357912 and HQ454321, respectively). The differences in our 16S and 50S rDNA sequences identified the presence of both '*Ca.* L. solanacearum' haplotypes D and E (4). To our knowledge, this is the first report of the occurrence of '*Ca*. L. solanacearum' in Morocco and Africa, suggesting a wider distribution of the bacterium in carrot crops in the Mediterranean region, including North Africa. '*Ca*. L. solanacearum' has caused economic damages to carrot and celery crops in the Canary Islands and mainland Spain, France, Sweden, Norway, and Finland (3). This bacterium has also caused millions of dollars in losses to potato and several other solanaceous crops in the United States, Mexico, Central America, and New Zealand (1,2,5). Given the economic impact of '*Ca*. L. solanacearum' on numerous important crops worldwide, it is imperative that preventive measures be taken to limit its spread.

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