

Diseases Caused by Fungi and Fungus-Like Organisms

First Report of Verticillium Wilt Caused by *Verticillium dahliae* Infection on Chinese Cabbage in Korea

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Chinese cabbage (*Brassica rapa* L.) is an important vegetable in Korea as the main ingredient for kimchi. In June 2014, symptoms of leaf wilt, drying, and drop off were observed in a Chinese cabbage farm located at Taebeak (37°26'50.7"N, 128°95'50.0"E), Gangwon province, Korea. This disease was observed on ~35% of plants in the field, causing an almost 10% decrease in production. At the early stage of infection, the color at the edge of the foliage changed from green to yellow. As the disease progressed, infected leaves wilted, dried off, and detached from the plant. Soft rot at the base of the leaf stem and root tissues caused the infected leaves to dry and fall off the plant. To identify the causal agent, a small piece of infected leaf tissue was sterilized with 1% NaOCl solution for 1 min and rinsed with sterile water before it was transferred onto PDA. The plates were incubated at 25°C for 10 days in the dark. Fungal colonies grown on PDA were white-creamy in color with an abundance of mycelia and later developed into black color due to the formation of microsclerotia embedded in the media. Microscopic examination showed conidiophores and phialides both appeared in a verticillate arrangement, whereas conidia were hyaline, smooth-walled, and ellipsoidal to oval with average size 5.4 × 2.5 μm ($n = 100$). Microsclerotia appeared in elongate to irregularly spherical shape and were greatly variable in size. Morphological attributes of the fungal isolate were comparable to *Verticillium dahliae* Kleb. described by Hawksworth and Talboys (1970) and *V. dahliae* isolated from Chinese cabbage in Japan reported in Kishi (1998). A pathogenicity test was

performed by soaking 12 individual Chinese cabbage seedlings for 15 min in fungal pathogen conidial suspension (1×10^6 conidium/ml) before transferring into a soil tray. The same number of noninoculated seedlings on the soil tray were a control. Inoculated and control plants were then covered with a plastic bag for 24 h to maintain high humidity before being transferred into the greenhouse (25°C). Seven days postinoculation (dpi), treated plant leaves turned yellow, and soft rot was observed. At 10 dpi, plant leaf tissues dried off and severe soft rot occurred. The pathogenicity test was repeated three times, and consistent results were obtained. The reisolated fungal pathogen from the inoculated plants showed identical morphological characteristics to the original isolates, thus fulfilling Koch's postulates. For further identification, PCR amplification targeting *ITS* and *RNA polymerase II gene (RPB2)* regions were performed (Liu et al. 1999; White et al. 1990). Each PCR product was sequenced and deposited in GenBank as LC549667 and LC061275, respectively. Sequence analysis using BLAST showed that the nucleotide sequences of *ITS* and *RPB2* DNA fragments are 99 to 100% identical to the reference strain of *V. dahliae* available in the NCBI database (MG585719, HE972023, XM_009652520, and DQ522468, respectively). Therefore, based on the results of morphological and molecular analyses, the fungal pathogen isolated from Chinese cabbage in this study was identified as *V. dahliae* and deposited in the National Institute of Horticultural and Herbal Science germplasm collection (NIHHS 13-252). Recently, due to high demand and a more competitive price, more chrysanthemum farmers in Korea switched their crops to Chinese cabbage. Interestingly, the occurrence of *V. dahliae* infection was also reported to occur in chrysanthemum plants in Korea (Han et al. 2007), which indicates a serious problem ahead for these farmers. Therefore, in this current study, the identification of *V. dahliae* pathogenic to Chinese cabbage will provide vital knowledge for the development of disease management strategies to minimize the loss of crop production. To our knowledge, this is the first report that *V. dahliae* causes Verticillium wilt disease on Chinese cabbage in Korea.

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