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Corky Root of Tomato Caused by *Pyrenochaeta lycopersici* in Korea

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Corky root symptoms caused by *Pyrenochaeta lycopersici* were observed on the roots and stem base of tomato plants in Korea. Symptoms on infected plants typically appeared as stunting and generally lacking vigor, and infected plants die back from the foliage tips after fruits have set. Brown lesions appearing with bands around the roots were characteristic symptoms of the disease. The lesions become swollen and cracked along the length of the root with corky appearance. Based on cultural and morphological characteristics, the fungus from the diseased plants was identified as *Pyrenochaeta lycopersici*. Pycnidia were solitary, globose to subglobose, brown to black, darker around the neck region, and measured 173-215 μm in diameter with septate setae up to 102-132×6.5 μm. Conidia were hyaline, unicellular, and 4.2-4.7×1.5-2.0 μm long. Optimum temperature for mycelial growth of the *P. lycopersici* isolates ranged from 20°C to 25°C. Fifteen isolates of *P. lycopersici* were tested for pathogenicity to susceptible and tolerant cultivars of tomato plants by artificial inoculation. Three isolates of *P. lycopersici* induced typical corky root discoloration on susceptible tomato cultivars but not on tolerant tomato. This is the first report in Korea of tomato corky root disease caused by *P. lycopersici*.

Keywords : corky root, *Pyrenochaeta lycopersici*, soil-borne pathogen, tomato

Corky root (brown root rot) has long been an important disease of tomato (*Lycopersicon esculentum* Mill.) in glasshouses in Europe. The causal agent of corky root had been known as the gray sterile fungus (GSF) until it was identified as *Pyrenochaeta lycopersici* Schneider & Gerlach (McGrath & Campbell, 1983). The pathogen is a slow growing organism and is difficult to isolate with consistency. Attempts to isolate the fungus by conventional isolation techniques and media frequently failed because of the presence of saprophytic fungi or other pathogens. From 1997 to 1999, 15 isolates of *P. lycopersici* were isolated from corky lesion on the roots of fresh market tomato, which were mainly grown in the greenhouse at Dalseong and Buyeo areas of Korea. The corky root symptoms of tomato caused by *P. lycopersici* include stunting and generally lack of vigor, and plants die back from the foliage tips after fruits have set (Fig. 1A). Brown lesions appearing with bands around the roots are characteristic symptoms of the disease. The lesions become swollen and cracked along the length of the root with corky appearance (Fig. 1B). The top roots and stem base may eventually turn brown and rot. Longitudinal section of an infected plant shows pith discoloration (Fig. 1C).

Tissue sections 10 mm square were taken from the centers of corky root lesions with a scalpel, placed on a screen-covered jar with tap water, washed for 5 minutes, surface-disinfested for 30 seconds in 1% NaOCl, rinsed with sterile distilled water, plated on semi-selective medium (Hockey and Jeves, 1984) and corky root medium (CRM), and placed on PDA to which the following compounds were added after sterilization and before pouring: 100 mg/ml each of chloroneb and triadimefon (each as 50% wettable powder to give 50 mg a.i./ml), plus streptomycin sulfate, penicillin, tetracycline, chloramphenicol (each at 100 mg/ml), and 50 mg/ml rose bengal, and incubated at 22°C for 7 days. Fifteen (15) isolates were obtained from this method, and all isolates formed microsclerotia and pycnidia on the PDA media (Fig. 1D).

All these isolates were identified as *P. lycopersici* Schneider & Gerlach based on pycnidial, conidial, and septate setae characteristics (Kuniyasu, 1990; Schneider & Gerlach, 1966; Table 1). Pycnidia were solitary, globose to subglobose, brown to black, darker around the neck region, and measured 173-215 μm in diameter with septate setae up to 102-132×6.5 μm (Fig. 1F). Conidia were hyaline, unicellular, and 4.2-4.7×1.5~2.0 μm long (Fig. 1E).

Corky root lesion was similar with the black dot root rot caused by *Colletotrichum coccodes* which formed black sclerotia abundantly in decayed tissue, but there was no typical corky lesions with infected by *C. coccodes*. Termohlen

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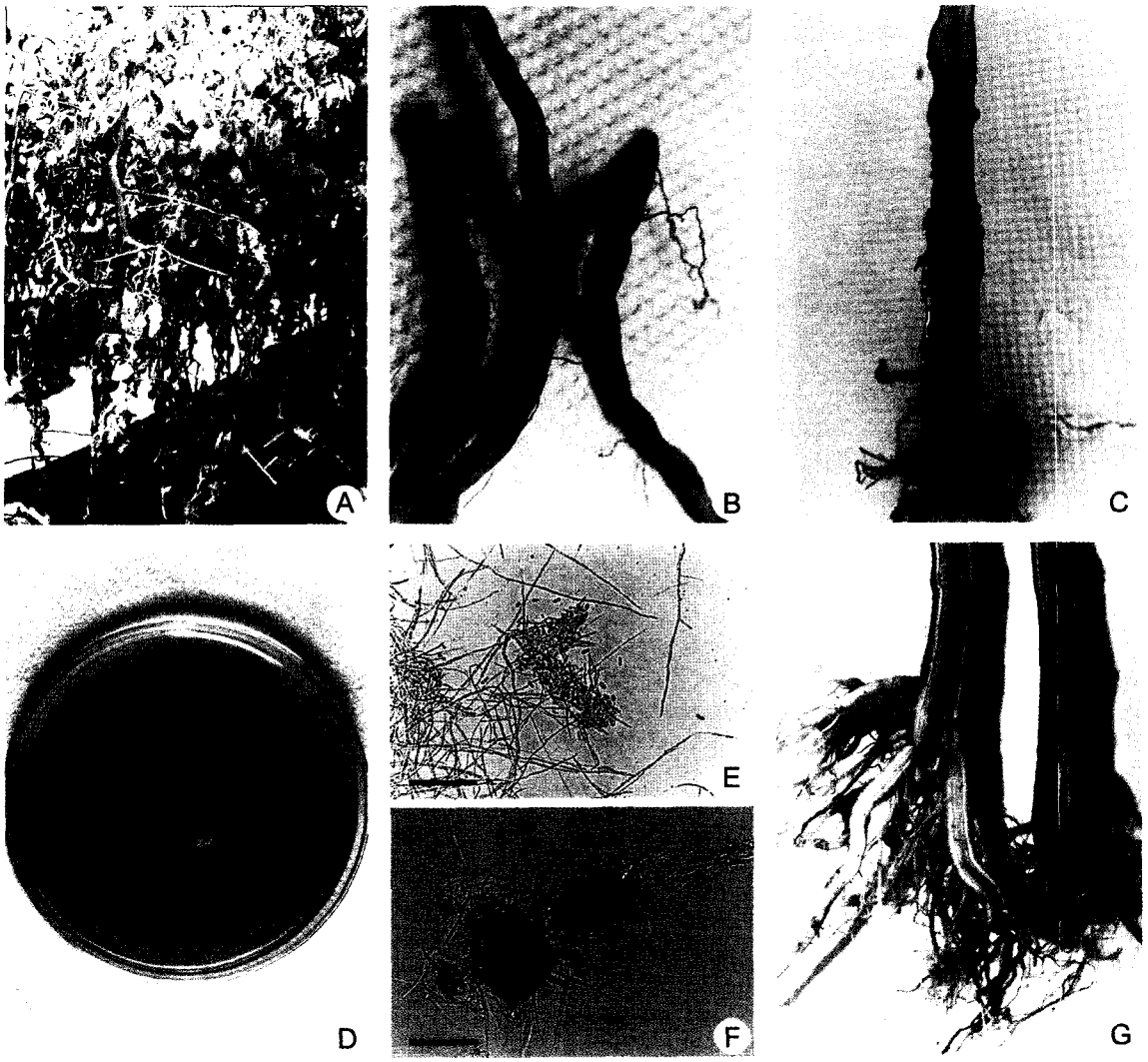

Fig. 1. Symptoms of tomato corky root in the greenhouse (**A-C**) and cultural characteristics of *Pyrenochaeta lycopersici*. (**D**) colony morphology on PDA medium, and (**E**) and (**F**) conidia and pycnidia of *P. lycopersici*; (**G**) root rot and pith discoloration were formed by artificial inoculation. Bar sizes: 10 μm (E), 100 μm (F).

(1962) reported that the two pathogenic fungi commonly isolated from infected roots were *P. lycopersici* as the primary pathogen and *C. coccodes* as the secondary pathogen. A similar disease occurred on greenhouse-grown tomatoes in Korea, and each of the two isolates of *P. lycopersici* (PI-01 and PI-11) and *C. coccodes* (Cc-01 and Cc-02) was tested at optimum temperature for mycelial growth. Optimum temperature for mycelial growth of *P. lycopersici* isolates ranged from 20°C to 25°C, whereas that of *C. coccodes* isolates, which is morphologically and culturally similar with the *P. lycopersici*, ranged from 20°C to 30°C (Fig. 2).

Fifteen (15) isolates of *P. lycopersici* were used for their pathogenicity to susceptible tomato cultivars Minicarol, Zuikoh No.102 and Momotaro, and tolerant tomato cultivars Joint and Vulcan. The inoculum concentration

Table 1. Comparison of morphological and cultural characteristics of *Pyrenochaeta lycopersici* isolated from tomato

Isolate	Size (μm)		
	Pycnidia	Septate setae	Conidia
TP-01 (*P. lycopersici*)	173.7~214.5	102.3~132.4	4.2~4.7×1.5~2.0
Schneider & Gerlath (1966)	150.0~300.0	120.0×7.0	4.5~8.0×1.5~2.0
Kuniyasu (1990)	156.7±32.4	125.0±5.6	4.2±0.3×2.2±0.2

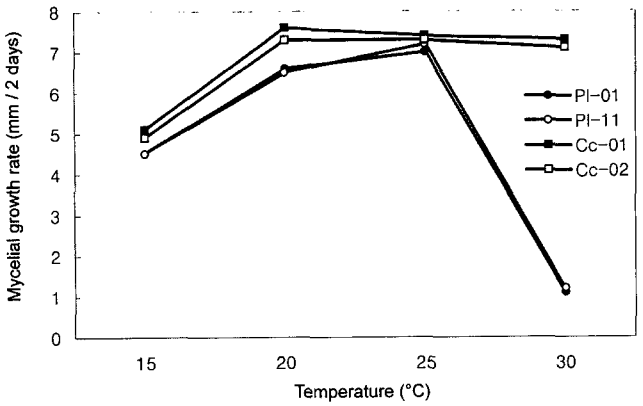

Fig. 2. Comparison of mycelial growth rate between *Pyrenochaeta lycopersici* and *Colletotrichum coccodes* on PDA at different temperatures for 2 weeks after incubation.

was adjusted to 10^7 conidia/ml. Tomato seedlings, grown in plastic pots in the greenhouse, were inoculated at the stage of the appearance of the 3-4th true leaf. These seedlings were uprooted and inoculated by the root-dip technique (Bender and Shoemaker, 1984). Uninoculated controls (seedlings dipped in PDA suspensions) were included. Disease severity of the 20 seedlings of each cultivar was determined 4 weeks after inoculation. Root rot and pith discoloration from inoculated tomato plants can be seen (Fig. 1G). The disease index of 0-4 based on discoloration on the taproots was used, where 0=healthy plants with no symptoms, 1=slight discoloration, 2=discoloration and one or two small lesions (about 1 mm^2 diameter), 3=general discoloration and several lesions, and 4=general necrosis of the entire taproot. Only three isolates Pl-01, Pl-11, and Pl-15 of *P. lycopersici,* were pathogenic to susceptible tomato cultivars Minicarol, Zuikoh No.102, and Momotaro. The susceptible seedlings were severely affected as 1.2 to 2.6 based on the 0-4 scale but tolerant seedlings Joint and Vulcan were rated from 0.2 to 0.8 (Table 2). Generally, typical corky root lesions developed on the roots of naturally infected plants. The severity rating was low in this study because the lesions developed on the roots, which were grown in plastic pots in the greenhouse. Several problems associated with cultures of *P. lycopersici* were loss of pathogenicity (Hubbeling, 1976) and loss of ability to sporulate (Campbell et al., 1982). Further, this fungus could compete poorly with other fungi as a saprophyte, and Davet (1976) has suggested that it is ecologically an obligate parasite. It rapidly degenerates in culture if maintained by mycelial transfers (Hall et al., 1980; Hubbeling, 1976). In their study of pycnidium producing strains of *P. lycopersici*, Gerlach and Schneider (1966) reported that there was no correlation between ability to form pycnidia and pathogenicity.

Table 2. Pathogenicity of *Pyrenochae lycopersici* against five tomato cultivars

Isolate	Disease index (0-4)[a]					
	Susceptible cultivar			Tolerant cultivar		Con.[b]
	Minicarol	Zuikoh No.102	Momotaro	Joint	Vulcan	
Pl-01	2.6[c]	1.8	1.2	0.4	0.7	0.4
Pl-11	2.2	2.2	1.7	0.3	0.6	0.2
Pl-15	2.1	2.0	1.3	0.8	0.2	0.2

[a] Disease index of 0-4 based on discoloration on the taproots was used, where 0=healthy plants with no symptoms, 1=slight discoloration, 2 =discoloration and one or two small lesions (about 1 mm^2 diameter), 3=general discoloration and several lesions, and 4=general necrosis of the entire taproot.

[b] Control: seedlings immersed in a pathogen-free agar slurry were used as uninoculated controls.

[c] Mean number of disease index with symptoms 4 weeks after inoculation, for 20 replicates of each cultivar. Error mean square=0.6.

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