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Stem Rot of Strawberry Caused by *Sclerotium rolfsii* in Korea

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A destructive stem rot of strawberry (*Fragaria* × *ananassa* cv. Akihime) sporadically occurred in farmers' fields in Daegok-myon, Jinju city, Gyeongnam province in Korea. The infected plants showed stem and crown rot, with occasional blighting of the whole plant. White mycelia appeared on stems of infected clones and sclerotia formed on the old lesions near soil surface. The fungus formed white colony on PDA and showed maximum mycelial growth and sclerotial formation at 30°C. The fungus usually have many narrow hyphal strands, 2.6-10.0 μm in width, in the aerial mycelium. Typical clamp connections were formed on the mycelium. Sclerotia were spherical and 1.0-2.4 mm in size. The fungus was repeatedly isolated from infected tissues and identified as *Sclerotium rolfsii*. Its pathogenicity was confirmed when inoculated onto strawberry. This is the first report on the stem rot of strawberry caused by *S. rolfsii* in Korea.

Keywords **:** *Sclerotium rolfsii*, stem rot, strawberry

Strawberry (*Fragaria* × *ananassa*) has been widely cultivated as a profitable crop in Korea. It is commonly cultivated in the greenhouse from September to April of the next year. This cultivation pattern has resulted to the occurrence of many unexpected diseases. Recently, a destructive stem rot of strawberry (cv. Akihime) sporadically occurred in farmers' fields in Daegok-myon, Jinju city, Gyeongnam province in Korea.

Sclerotial diseases caused by sclerotium primarily occur in warm climates, especially at high moisture and temperature. The pathogens of sclerotial diseases cause damping-off of seedlings, stem canker, crown blight, and rots on root, crown, bulb, tuber, and fruit. Sclerotial diseases frequently affect a wide variety of plants, including most vegetables, flowers, legumes, cereals, forage plants and weeds (Agrios, 1997).

The disease is generally called sclerotinia rot. Several papers have reported that sclerotinia rot on strawberry is caused by *Sclerotium rolfsii* (Farr et al., 1995; Kishi, 1998; The Phytopathological Society of Japan, 2000). Mordue (1972) suggested that *S. rolfsii* is synonymous in its sclerotial state to *Corticium rolfsii*. However, sclerotial stem rot of strawberry has not been reported in Korea (The Korean Society of Plant Pathology, 1998).

Disease occurrence. In Gyeongnam area, strawberry seedlings are transplanted in vinyl houses in September and cultivated until March of the following year. The cultivation conditions in vinyl houses usually include high temperature and humidity for the growth of the plants, consequently resulting to numerous water drops formed on the leaves and stems of strawberry. This cultural condition stimulates the development of sclerotium stem rot in many spots in the fields (Fig. 1A). The infection rate of surveyed areas was 8.6% in March 2003.

Symptom. On infected plants, fungal hyphae grew upward on the surface of stems and covered the lesion with white mass of mycelium. The white mycelium grew inside and outside of the infected stems and spread on the old lesions near the soil surface. The fungus produced numerous small roundish sclerotia of uniform size, which were white at first and became brown to dark-brown on both PDA and host. The fungus grew into the stems and eventually caused plant wilt and blight death (Fig. 1B).

Mycological characteristics. The causal fungus was easily isolated on water agar (WA) and grew well on potato dextrose agar (PDA). Diameter of mycelial growth was measured after 62 hours of incubation on PDA with three replicates. The mycelium of the fungus did not grow below 5°C or over 45°C. The temperature range for mycelial growth on PDA was between 10 and 40°C, and the optimum temperature was 30°C. The white mycelium usually formed many narrow hyphal strands in the aerial mycelium measuring 2.6-10.0 μm in width. This mycelium showed typical clamp connection structure (Fig. 1E).

Sclerotia were investigated for their characteristics after mycelial growth for 20 days. Small and globoid sclerotia were produced on the surface of lesions. They were white at first but became dark-brown after maturity, showing relatively uniform sizes (Fig. 1D). The maximum number of sclerotia was produced at 30°C, but the formation of

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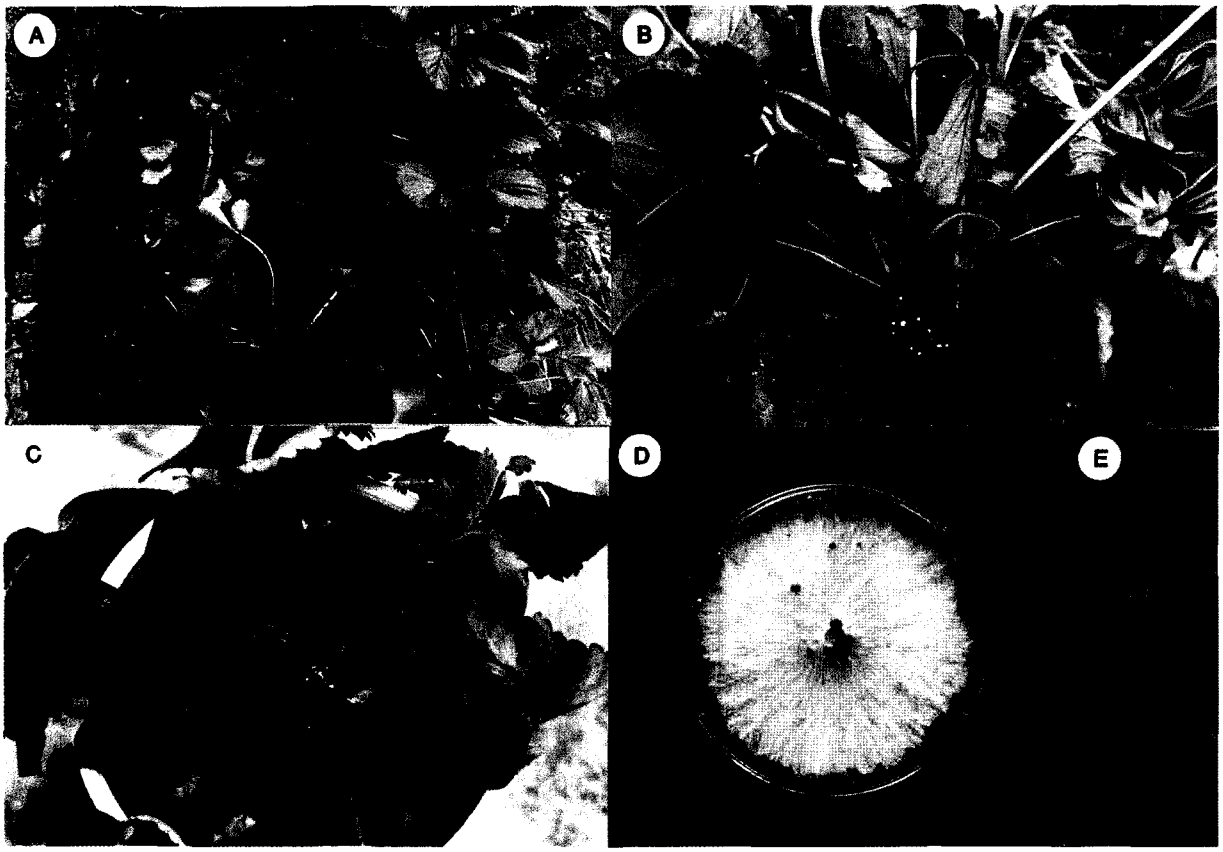

Fig. 1. Symptoms of stem rot of strawberry (*Fragaria* × *ananassa*) and mycological characteristics of the pathogenic fungus *Sclerotium rolfsii*. (**A**) View of strawberry stem rot in vinyl house; (**B**) Close view of strawberry stem rot caused by *S. rolfsii*; (**C**) Symptom on diseased strawberry by artificial inoculation; (**D**) Mycelium and sclerotia formed on PDA after 20 days of incubation; (**E**) Hyphae and typical clamp connection structure of *S. rolfsii*.

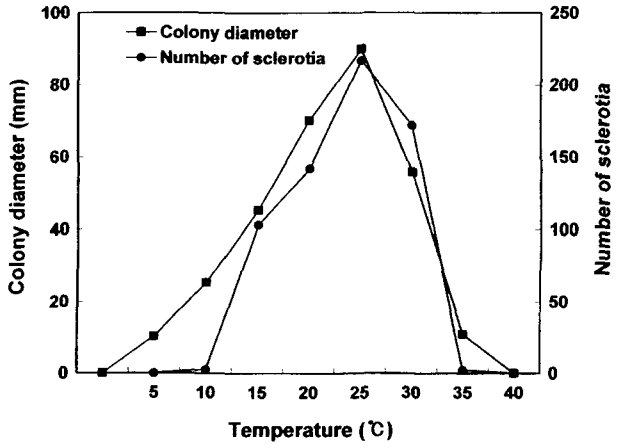

Fig. 2. Effects of temperature on mycelial growth and sclerotia formation of *Sclerotium rolfsii*. Diameter of mycelial growth of *S. rolfsii* was measured after 62 hours of incubation on PDA (■-■). The number of sclerotia was counted after 20 days of incubation (●-●). The data are means of three replicates.

sclerotia was sharply reduced below 20°C or over 35°C on PDA. However, no sclerotia were observed below 10°C or over 40°C. Sclerotia were mostly spherical, 1.0-2.4 mm in size (Fig. 2, Table 1).

Pathogenicity test. The pathogenicity of the fungus to strawberry plants was tested in the greenhouse. Strawberry plants were grown in the greenhouse for 96 days. The plants were planted in Wagner pots (1/5000a) filled with field soil which was autoclaved three times. The plants were inoculated with fungal mycelial mats on the stems. Inoculum was prepared with mycelial mats grown on PDA for 4 days. The first symptom appeared within 12 days after inoculation and the symptom developed to severe stem and crown rotting and wilting, eventually causing the death of the plant (Fig. 1C). The same fungus was re-isolated from artificially infected plants with severe symptoms.

The pattern of mycelial outgrowth on the infected plants, the aerial mycelium, and the typical clamp connection structure were the factors considered in differentiating *S. rolfsii* from other species in the genus *Sclerotium*.

S. rolfsii is often referred to as *Athalium rolfsii*. However, its perfect stage has not been confirmed yet. The characteristics of the present isolates were identical with *S. rolfsii*

Table 1. Mycological characteristics of the fungus isolated from the stem rot of strawberry and of *Sclerotium rolfsii* described by Mordue and Kishi

Characteristic		Present isolate	Mordue (1972)	Kishi (1998)
Colony	color	white	white	white
Hyphae	diameter	2.6-10.0 μm	4.5-9.0 μm	1.5-10.3 μm
	clamp connection	present	present	present
Sclerotium	shape	spherical	spherical	spherical
	size	1.0-2.4 mm	1.0-2.0 mm	0.9-2.1 mm
	color	brown	brown	brown to dark-brown

described by previous workers (Farr et al., 1995; Mordue, 1972; Kishi, 1998).

Sclerotium sp. causes stem, branch, root, bulb, and tuber rot in herb and woody plants (Gobayashi et al., 1992). In this study, the causal fungus of stem rot disease of strawberry was identified as *S. rolfsii.*

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