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Stem Rot of Garlic (*Allium sativum*) Caused by *Sclerotium rolfsii*

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Stem rot disease was found in garlic (*Allium sativum* L.) cultivated from 2008 to 2010 in the vegetable gardens of some farmers in Geumsan-myon, Jinju City, Gyeongnam province in Korea. The initial symptoms of the disease were typical water-soaked spots, which progressed to rotting, wilting, blighting, and eventually death. White mycelial mats had spread over the lesions near the soil line, and sclerotia had formed over the mycelial mats on the stem. The sclerotia were globoid in shape, 1~3 mm in size, and tan to brown in color. The optimum temperature for growth and sclerotia formation on potato dextrose agar (PDA) medium was 30°C. The diameter of the hyphae ranged from approximately 4 to 8 μm. Typical clamp connection structures were observed in the hyphae of the fungus, which was grown on PDA medium for 4 days. On the basis of the mycological characteristics and pathogenicity of the fungus on the host plants, the causal agent was identified as *Sclerotium rolfsii* Saccardo. This is the first report of stem rot disease in garlic caused by *S. rolfsii* in Korea.

KEYWORDS : *Allium sativum*, Garlic, *Sclerotium rolfsii*, Stem rot disease

Stem rot disease of garlic was found in small-scale vegetable gardens in Geumsan-myon, Jinju City, Gyeongnam province, from 2008 to 2010. The diseased plants were brought to a laboratory for examination. Whitish mycelia and small brownish spherical sclerotia on the stems and basal portions of the diseased plants were examined. The causal fungus was isolated purely, and its mycological characteristics and pathogenicity were documented.

Disease symptoms. The disease occurred in the crown and stem of the garlic plants. The initial symptoms were water-soaking lesions that became soft and then rotted. The infected plants showed poor growth, wilted, and gradually died (Fig. 1A). White cottony mycelia formed on the stems of the diseased plants, which became tough and formed abundant amounts of brown spherical sclerotia on the surface of the mycelial mat.

Environmental conditions for disease development. Initially, stem rot disease affected only a small number of garlic plants; however, the disease gradually spread and caused large-scale damage. The symptoms of the disease began in May, when the canopy of the garlic plant became densely covered, blocking air flow and light. In late May, relatively high air temperatures and frequent rain fall favored disease development. According to farmers who had experience with this disease, the disease becomes troublesome only when environmental conditions favor disease development. Stem rot disease of garlic is a soil-borne disease, the inoculum potential of which increases in continuously mono-cropped areas. It is presumed that the debris of infected plants is main inoculum source of the disease. Abundant sclerotia are formed on the stems and bulbs of infected plants, and the sclerotia are overwintered and invade the root, crown, and stem when garlic is planted (Fig. 1B).

Isolation of causal organism. The causal organism of garlic stem rot was isolated from the sclerotia formed on the stems of the infected plants. Thirty typical sclerotia had formed on the stems of the garlic samples collected. The surfaces of the collected sclerotia were disinfected with a 1% NaOCl solution for 1 min, rinsed with sterilized water 3 times, and blotted with 5 layers of flame-sterilized filter papers (90 mm). The surface-sterilized sclerotia were placed on potato dextrose agar (PDA) medium and incubated at 25°C for 4 days. The fresh mycelia grew out from sclerotia on agar surface were cut with spatula and transferred to new PDA and incubated at 25°C.

Observation of mycological characteristics. The causal organism was cultivated in PDA for 3 wk, and the morphology of the hyphae and clamp connection structure and sclerotia formation were examined under light microscopy (Table 1). The mycelia were white and grew fast and prosperously on the surface of the PDA and had a cottony appearance. The sclerotia formed readily on the PDA (Fig. 1D), were tan to brown in color, and were generally spherical, although some were irregularly shaped. The sclerotia were 1~3 mm in diameter, and they had a glossy surface. After a 4-day incubation period on PDA at 25°C, a typical clamp connection structure was observed

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Fig. 1. Symptoms of stem rot of garlic (*Allium sativum*) and mycological characteristics of the pathogenic fungus *Sclerotium rolfsii*; A, Typical symptoms occurred on the stems and bulbs; B, The mycelial mat and sclerotia formed on the debris of infected plants in the field; C, Symptoms appeared after artificial inoculation on stems and near the soil line in the pot; D, Mycelial mat and sclerotia grown on potato dextrose agar after 18 days of incubation; E, Clamp connection structure formed on the hyphae of the fungus (arrow).

Table 1. Comparison of the mycological characteristics of a present isolate obtained from *Allium sativum* and *Sclerotium rolfsii* described previously

Characteristics		Present isolate	*S. rolfsii* [2]
Colony	Color	White	White
Hyphae	Diameter (μm)	4~8	4.5~9
	Clamp connection	Present	Present
Sclerotium	Shape	Globoid	Spherical
	Diameter (mm)	1~3	1~2
	Color	White to brown	Brown

in the hyphae (Fig. 1E). The diameter of the hyphae ranged from approximately 4 to 8 μm, and the optimal temperature for growth of the fungus was 30°C.

The causal organism of stem rot disease in garlic and the associated symptoms agreed with the findings of Kishi [1], and the mycological characteristics of the fungus agreed with those reported by Mordue [2].

Pathogenicity test. The pathogenicity of the fungus was examined in a garlic plant grown in 1/5000a Wagner's pots. Three bulbs of health garlic were planted in Wagner's pots (10 replication) in October 2008. The test plants were inoculated with the isolated fungus in April, 2009. The inoculum of the fungus was prepared by mixing fungal mycelia and soil 5 kg of sandy loam soil was sieved and autoclaved at 121°C for 30 min. and repeatedly autoclaved 3 times at 5-day intervals. The mycelial mat of the test fungus grown on PDA for 7 days was harvested. The harvested mycelial mat from 30 petri dishes (9 cm in diameter) was mixed thoroughly with 5 kg of sterilized soil in a plastic container (56 × 35 × 13 cm). The mixture containing the mycelial mat and the soil was dried in the shade for 15 days and then powdered. The powdered mixture was preserved in a green house and used as inoculums; 200 g of soil inoculum was placed on top of the Wagner's pots. After infestation of inoculum, 500 mL of tap water was added to each pot and covered with one layer of newspaper to maintain sufficient soil moisture. The inoculated pots were kept separately in a green house and were observed for disease symptoms. Seven days after inoculation, white mycelia on the stems of the garlic and premodia of sclerotia were observed. As time progressed, the premodia of sclerotia developed into typical brownish sclerotia, and the white mycelia on the stem and soil surface had typical stem rot symptoms (Fig. 1C). The infected plants gradually wilted and eventually died.

In recent years, many diseases caused by *Sclerotium rolfsii* in various crops have been reported [3-6]. The disease described in this article and the mycological characteristics of the causal organism were in line with these

reports. On the basis of the results obtained in this study, the author suggested that the disease observed was stem rot of garlic caused by *S. rolfsii* Saccardo. The isolate obtained from garlic in this study was deposited in the Korean Agricultural Culture Collection and was assigned the registration number KACC No. 43068.

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