

Scab of Tea (*Thea sinensis*) Caused by *Cladosporium herbarum* in Korea

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In 2001, a black scab disease was observed in tea plant (*Thea sinensis*) cultivated in the hillsides of Hwagae-myon and Hadong-gun, Gyeongnam province, Korea. The disease symptoms initially appeared on leaves, green twigs and stems, showing small dark brown spots on the infected areas, which gradually expanded. A fungus was isolated from diseased leaves and green twigs. It grew readily on potato dextrose agar, forming dark green to dark gray colonies. The optimum temperature for mycelial growth was about 20°C. The diameter of growing hyphae was 3.5-5.8 µm. Conidia were ellipsoidal, ovoid or subspherical, and mostly one-celled but occasionally septate. The size of one-celled and septate conidia were 3.7-12.4 × 3.4-5.2 µm and 9.3-18.7 × 3.8-7.2 µm, respectively. Conidia were formed in long branched chains on the erected conidiophores, which were dark brown in color and 28.9-218.3 × 3.0-6.1 µm in length. The fungus was identified as *Cladosporium herbarum* on the basis of its morphological characteristics. The black scab disease occurring in tea caused by *Cladosporium herbarum* has not been previously reported in Korea.

Keywords : *Cladosporium herbarum*, scab, tea, *Thea sinensis*.

Plant diseases caused by *Cladosporium* are common and widely distributed in vegetables, fruits and even in some field crops throughout the world. The diseases commonly occur in crops growing in open fields and mountain areas, and are especially severe in the family Theaceae. Under humid conditions, the fungus produces noticeable dark brown mycelia on the affected tissues, which is a typical sign of *Cladosporium* disease. The fungus requires cool, damp weather conditions for vivid growth, sporulation, spore release, germination, and disease development. *Cladosporium* spp. are active at low temperatures and high

humidity. The scab disease due to *Cladosporium* spp. often just covers the surface of the plant without deep penetration, and causes interference of photosynthesis. The ectoparasitic colonization of the fungus overcomes the other parasitic and saprophytic organisms (Takuda and Suehara, 1970).

Cladosporium herbarum (Persoon and Fries) has been known as an important pathogen, which invades a wide range of host tea plants in Japan (Udagawa et al., 1980; Kiba, 1959; Takuda and Suehara, 1970). Although *C. herbarum* causing scab diseases in barley, rice, and pepper have been reported in Korea, the detailed characteristics of the fungus or the disease symptoms are rarely described. The scab disease incited by *C. herbarum* in tea has not been previously reported in Korea (The Korean Society of Plant Pathology, 1998).

During the spring and summer of 2001, a disease suspected as black scab was found in tea plants growing in open fields at the hillsides of Hwagae-myon, Hadong-gun, Gyeongnam province, Korea. In some areas, infection rate was as high as 26.4% depending on the location and field conditions. The causal fungus mostly penetrated into host tissues through wounds caused by harvesting or strong winds. Diseased leaves, green twigs and stems were collected from tea plants growing in the hillsides, and a pure isolation was made from conidia that formed on the dark green mycelial mass on potato dextrose agar (PDA). This fungus was incubated in the dark at 20°C, and the mycelia, conidia and conidiophores that formed on the agar plate were observed under a light microscope (Fluophot, Nikon, Japan). The mycelial growth of the fungus at various temperatures and other characteristics of the fungus were also examined.

The mycological characteristics of the fungus isolated in this experiment were compared with descriptions of those reported previously (Table 1). The size and width of the conidia, conidiophores, and mycelia were measured with an image analysis program (Image pro 4.0). Colonies on PDA were densely packed with dark green color and mycelial width was 3.5-5.8 µm. Conidia often formed in long-

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Table 1. Comparison of morphological characteristics of a pathogenic fungus isolated from scab disease of tea (*Thea sinensis*) and *Cladosporium herbarum* described previously

Characteristics	Present isolate	<i>C. herbarum</i> ^a
Colony		
color	dark green	dark green
size	3.5-5.8 μ m	4.0-5.0 μ m
Conidia		
color	dark brown	dark brown
size	one-celled (3.7-12.4 \times 3.4-5.2 μ m) two-celled (9.3-18.7 \times 3.8-7.2 μ m)	one-celled (4.5-11 \times 4-5 μ m) two-celled (9-15 \times 4-7 μ m)
septa	0-1	0-1
shape	ellipsoid, chain, arborescent	ellipsoid, chain, arborescent
Conidiophore		
color	dark brown	dark brown
size	28.9-218.3 \times 3.0-6.1 μ m	25-225 \times 3-6 μ m

^aDescribed by Udagawa et al. (1978).



Fig. 1. Symptoms occurring in tea caused by *Cladosporium herbarum*. Dark brown sooty mold surrounded by dark green fungal mats in naturally infected leaf on the upper (A) and lower (B) surfaces. Infected stem (C), green twig (D), artificially inoculated leaves (E), and inoculation after cutting tea in open field (F).

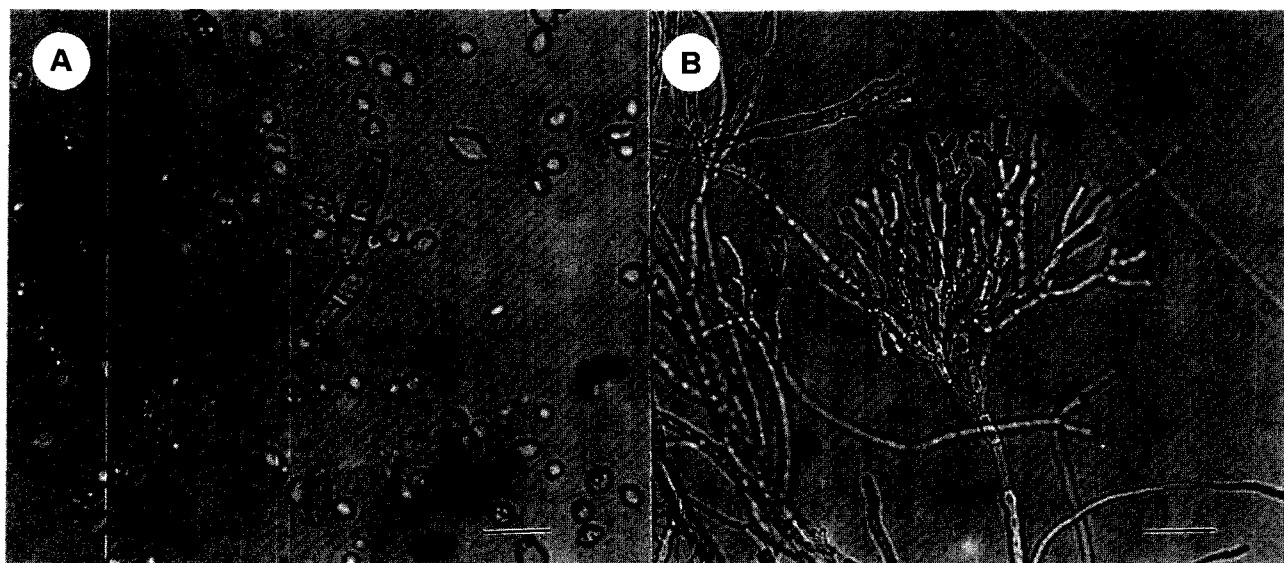


Fig. 2. Morphological characteristics of *Cladosporium herbarum*, the pathogen of tea scab. Typical conidia (A) and conidiophores (B). Bars indicate 10 μm .

branched chains, and were variable in shape and size; mostly lemon shaped, sometimes ellipsoidal, ovoid to cylindrical irregular, arborescent, dark, and one- or two-celled. The one-celled conidia were $3.7\text{--}12.4 \times 3.4\text{--}5.2 \mu\text{m}$ in length, while the two-celled conidia were $9.3\text{--}18.7 \times 3.8\text{--}7.2 \mu\text{m}$ in length (Fig. 2A). The conidiophores were dark brown, smooth, tall, upright, branched variously near the apex, clustered or single, and $28.9\text{--}218.3 \times 3.0\text{--}6.1 \mu\text{m}$ in size (Fig. 2B). The symptoms on leaves, stems, and green twigs of tea are shown in Figure 1A-1D. The morphology and other mycological characteristics were almost identical as those described by Udagawa et al. (1980) (Table 1). Accordingly, this study identified the present isolate as *Cladosporium herbarum* Persoon and Fries (Barnett and Hunter, 1986; Gobayashi et al., 1992; Farr et al., 1972; Udagawa et al., 1980).

Low temperature was favorable to the growth of the fungus. The maximum temperature for mycelial growth was 30°C while the minimum was 5°C , with optimum temperature of 20°C (Fig. 3). Naturally, the tea scab disease prevailed in low temperature and high humidity in the fields. The isolated fungus successfully induced the typical scab symptoms when the fungus was inoculated onto tea plant. The infected lesions were usually surrounded by dark green or dark gray soot. In the inoculated plants, lesions with dark soot developed on young and old leaves, green twigs and stems, followed by small and irregular lesion formation. Under cool and humid conditions, the disease developed rapidly on the leaves. However, in hot and dry weather conditions, no new lesions appeared on the tea plants, and previously formed lesions did not grow any bigger but

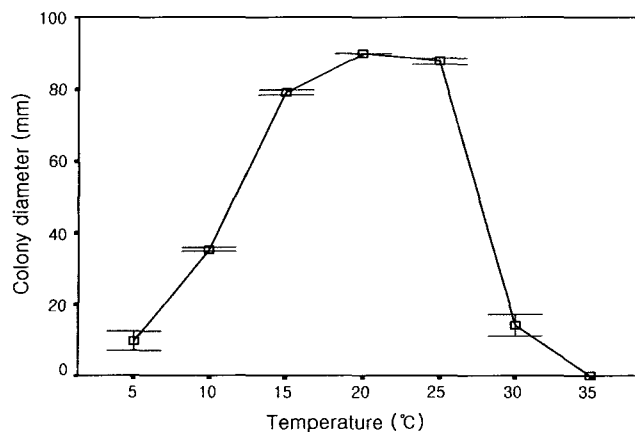


Fig. 3. Effect of temperature on mycelial growth of *Cladosporium herbarum*, the causal organism of scab disease of tea (*Thea sinensis*). Linear mycelial growth was measured 28 days after incubation on potato dextrose agar. Data are means of three replications. Bars represent standard deviations.

remained as small dark green soot. When 3-year-old tea seedlings were artificially inoculated with conidial suspensions ($10^5/\text{ml}$), only the wound inoculation was successful in inducing the disease. Early symptoms on leaves appeared 14 days after inoculation (Fig. 1E). The leaves of the seedlings became soft and were broken, dried, and eventually died. The symptoms on the artificially infected plants were almost identical to those of naturally infected plants. The causal fungus, *C. herbarum* was re-isolated from the inoculated tea. Morphological characteristics of the re-isolated fungus did not differ from that isolated from naturally

infected plants. Disease development in cultivated tea plant was greatly influenced by the inoculum (Fig. 1F).

Environmental conditions in spring and summer in tea growing areas, such as low temperature and high humidity, are often favorable for the growth of scab fungus. Hand picking of young tea leaves and strong wind at this time of year also contribute to the occurrence of scab disease. *C. herbarum* readily penetrates leaf tissues through wounds. This is the first report that describes the disease occurrence, symptom development, and causal organism of the scab disease in tea in Korea.

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