

## Occurrence of Strawberry Scab Caused by *Cladosporium herbarum* in Korea

Jin-Hyeuk Kwon\*, Soo-Woong Kang<sup>1</sup>, Jeong-Soo Kim<sup>1</sup> and Chang-Seuk Park<sup>2</sup>

Gyeongsangnam-do Agricultural Research and Extension Services, Jinju 660-360, Korea

<sup>1</sup>Department of Agricultural Science, Chinju National University, Jinju 660-758, Korea

<sup>2</sup>College of Agriculture, Gyeongsang National University, Jinju 660-701, Korea

A black scab was observed on strawberry (*Fragaria ananassa*) in plastic film houses around Jinju area during the winter of 2000. The disease started from leaves then moved to calyx and runner. At the beginning, the infected area started with small dark brown spots then gradually expanded. The pathogenic fungus was purely isolated from the diseased leaves, calyx and runner. The fungus was inoculated to test Koch's postulates and proved to be the causal agent of the disease. The isolated fungus grew readily on potato dextrose agar, forming dark green to dark gray colonies. The optimum temperature for mycelial growth was about 25°C. The diameter of growing hyphae was 3.8–5.6 µm. Conidia were ellipsoidal, ovoid or subspherical, mostly one-celled but occasionally septate. The size of conidia were 4.1–11.7×3.8–5.3 1-cell, 9.3–18.8×4.0–7.4 µm 2-cell and formed in long branched chains on the erected conidiophores which were dark brown and variable in length between 28.8–236.2×3.0–6.2 µm in size. The fungus was identified as *Cladosporium herbarum* on the basis of its morphological characteristics. The black scab disease of strawberry caused by *C. herbarum* has not been reported in Korea previously.

**KEYWORDS:** *Cladosporium herbarum*, Strawberry, Scab

*Cladosporium* diseases are common and widely distributed in vegetables, fruits and even some field crops throughout the world. The diseases are commonly occurred on crops grown in green houses, especially on cucurbitae family. Under humid conditions, the fungus produces a noticeable dark brown mycelia on the affected tissues which is the most typical sign of *Cladosporium* diseases. The fungus requires cool, damp weather for vivid growth, sporulation, spore release and germination, and disease establishment. The *Cladosporium* spp. are active at low temperatures and high humidity. The scab disease due to *Cladosporium* spp. often cover the surface of the plant without deep penetration, and cause interference of photosynthesis. The ectoparasitic colonization of the fungus attracts other parasitic and saprophytic organisms.

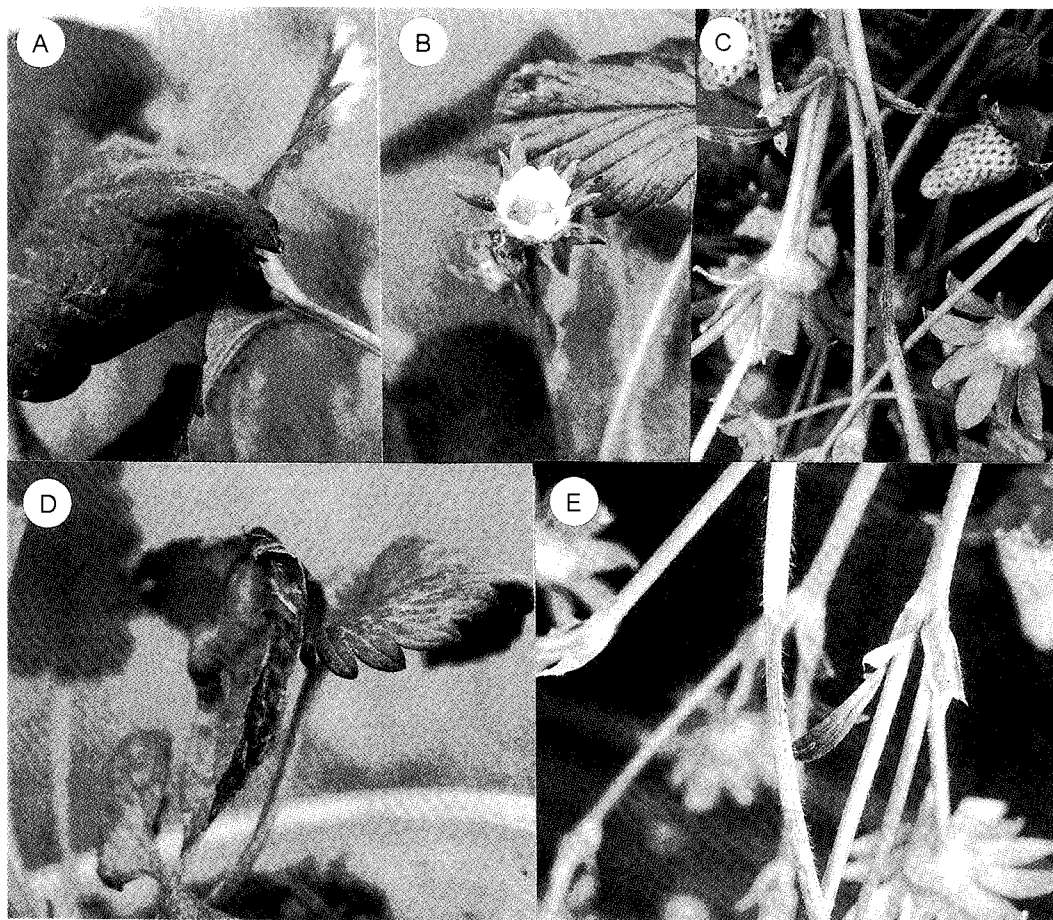
*C. herbarum* (Persoon & Fries) has been known as an important pathogen which has wide range of host plants including strawberry throughout the world (Udagawa *et al.*, 1980). However, only a few descriptions on the diseases that caused by *C. herbarum* were found in the literatures in Korea. Although it was recorded that *C. herbarum* cause scab disease in barely, rice and pepper, detailed characteristics of the pathogenic fungus or disease symptom were not described (Chung *et al.*, 1977; Lee and Lamey, 1975). The scab disease incited by *C. herbarum* on strawberry has been not reported in Korea (The Korean Society of Plant Pathology, 1998).

In the winter of 2000, a disease suspected as black scab was found on strawberry growing in greenhouses around Jinju area. In some area, infection rate was as high as

7.4% depending on greenhouse conditions. However, the damage was not so severe. Diseased leaves, calyxes and runners were collected from strawberry (cv. Janghee) growing in the greenhouses, and the conidia on the dark green mycelial mass formed on the runner were isolated and cultured on potato dextrose agar. This fungus was kept and incubated in the dark at 25°C. Mycelia, conidia and conidiophores were carefully observed under the light microscope (Nikon Fluophot, Japan). The mycelial growth of the fungus at various temperatures and the morphological characteristics of the fungus were examined. The symptoms appeared on the leaves, calyxes and runners of strawberry (Fig. 1A, B, C). The mycological characteristics of the pathogenic fungus isolated from diseased strawberry were compared with descriptions of those reported previously (Table 1). The morphology and other mycological characteristics were almost identical with Udagawa's description. Colonies on PDA were densely packed with dark green color and were 3.8–5.6 µm in size. The conidia were formed often in simple or in long branched chains, and conidium was variable in shape and size, some typically lemon shaped, ellipsoidal, ovoid to cylindrical irregular, arborescent, dark, 1-2 celled, mostly aseptate. The length of the conidium was 4.1–11.7×3.8–5.3 µm 1-cell or 9.3–18.8×4.0–7.4 µm 2-cell in size (Fig. 2A). The conidiophore was dark brown, smooth, tall, dark, upright, branched variously near the apex, clustered or single, and variable in size of about 28.8–236.2×3.0–6.2 µm (Fig. 2B).

Accordingly, we identified the presented isolate as *C. herbarum* (Persoon & Fries) (Barnett and Hunter, 1986; Gobayashi *et al.*, 1992; Farr *et al.*, 1972; Udagawa *et al.*,

\*Corresponding author <E-mail: kwon825@mail.knrda.go.kr>



**Fig. 1.** Symptoms occurred on strawberry incited by *Cladosporium herbarum*. Dark brown sooty surrounded by dark green fungal mats on naturally infected leaves (A), calyx (B) and runner (C). Artificially inoculated leaves (D) and runner (E).

1980).

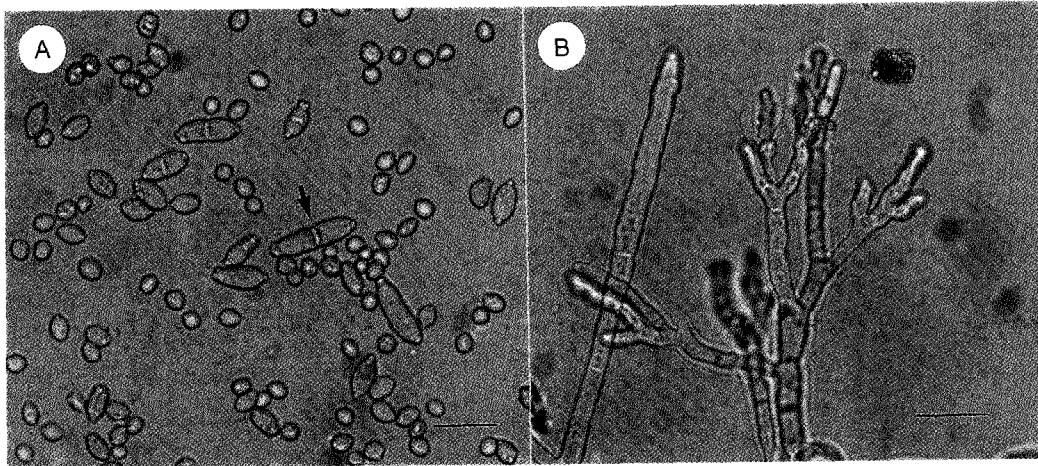
The maximum temperature for mycelial growth was 35°C and the minimum growth temperature was 5°C, and the optimum growth temperature was 25°C. The isolated fungus successfully induced the typical scab symptoms on strawberry. The infected tissues were usually surrounded by dark green or dark gray soot on lesions. In inoculated

plants, the lesions were developed on the young and old leaves, calyxes and runners with sunken and dark soot, followed by small and irregular lesion formation. The size of lesions formed on the runner were 8.0~115.4 µm. Under the cool and humid environmental conditions, the disease developed rapidly and gummy substances were exuded from the runner. However, in hot and dry weather condi-

**Table 1.** Comparison of morphological characteristics of the pathogenic fungus of scab disease of strawberry with *Cladosporium herbarum*

Characteristics	Present study	<i>C. herbarum</i> <sup>a)</sup>
Colony color	dark green	dark green
size	3.8~5.6 µm	5.0~4.0 µm
Conidia		
color	dark brown	dark brown
size	1-cell (4.1~11.7×3.8~5.3 µm) 2-cell (9.3~18.8×4.0~7.4 µm)	1-cell (4.5~11×4~5 µm) 2-cell (9~15×4~7 µm)
septa	0~1	0~1
shape	ellipsoid, chain, arborescent	ellipsoid, chain, arborescent
Conidiophore		
color	dark brown	dark brown
size	28.8~236.2×3.0~6.2 µm	25~225×3~6 µm

<sup>a)</sup>Described by Udagawa *et al.*, (1978).



**Fig. 2.** Typical conidia (A) and conidiophore (B) of *Cladosporium herbarum*. Conidia are mostly ovoid and single cell. However occasionally septated conidia also can be seen (A) (arrows). The conidiophores are erect and branched (B). Bar indicate 10  $\mu\text{m}$ .

tion, no new lesions were appeared on strawberry, and previously formed lesions were not enlarged and remained as small dark green soot. When seedlings of strawberry (cv. Janghee) were inoculated with conidial suspensions ( $10^5/\text{ml}$ ) artificially, leaves and calyxes of the seedlings were softened, broken down, dried and eventually died. Early symptoms of leaves and calyxes were appeared eight days after the inoculation (Fig. 1D, E).

The symptoms on the artificially infected plants were almost identical to those of naturally infected plants. The causal fungus, *C. herbarum* was reisolated from inoculated strawberry. Morphological characteristics of the conidia and mycelia of the fungus that were reisolated from inoculated plants were the same as those of naturally infected one.

The diseases caused by *C. herbarum* in barely, pepper and rice have been reported in Korea. However, only the name of disease, host plants and causal organism were recorded in previous literatures (Lee and Lamey, 1975; Chung *et al.*, 1977; The Korean Society of Plant Pathology, 1998). There have been no report on the scab disease caused by *C. herbarum* in Korea. In recent years, many of the strawberry cultivations are conducted in winter season. The environmental conditions for winter growing strawberries in plastic film houses are mostly favorable for the growth of scab fungus. Consequently it is expected

that scab disease of strawberry become prevail during the winter season. This is the first report that describes the disease occurrence, symptom development and causal organism of scab disease on strawberry in Korea.

## References

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