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Occurrence of Rhizopus Soft Rot on Squash (*Cucurbita moschata*) Caused by *Rhizopus stolonifer* in Korea

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A soft rot caused by *Rhizopus stolonifer* occurred on squash (*Cucurbita moschata*) in plastic film houses in Chinju area during spring season of 2000. The disease infection usually started from flower, peduncle and young fruits, then moved to flower stalk, stem and leaves. At first, the lesions started with water-soaked, rapidly softened, and then the area gradually expanded. In severely affected film house, the rate of infected fruits reached to 28.6%. Numerous sporangiospores were formed on the diseased fruits, flower stalk, stem and leaves. Most of the sporangiospores were appeared to be readily dispersed in the air. The mycelia grew on the surface of host and formed stolons. Colonies on potato dextrose agar were cottony at first brownish black at maturity. Sporangia were 125.3 × 294.2 µm. globose or sub-globose with somewhat flattened base. White at first the black, many spored, and are never overhanging. Sporangiophores were 2.7-6.8 × 12.9-33.9 µm, smooth-walled, non-septate, light brown, simple, long, arising in groups of 3-5 from stolons opposite rhizoids. Sporangiospores were 8.6-21.1 × 6.41-1.7 µm, irregular, round, oval, elongate, angular and browinish-black streaked. Columella were 63.8 × 140.4 µm. brownish gray, umberella-shaped when dehisced. The causal organism was identified as *Rhizopus stolonifer* Lind on the basis of the morphological characteristics of the fungus. Rhizopus soft rot on squash (*Cucurbita moschata*) caused by the fungi has not been previously reported in Korea.

Keywords **:** *Rhizopus stolonifer,* Rhizopus soft rot, squash (*Cucurbita moschata*).

The soft rot on fruits and foliage caused by *Rhizopus* sp. occurs throughout the world on harvested fleshy organs of vegetables, ornamental crops and during storage, transit, and marketing of these products. *Rhizopus* exists everywhere usually as a saprophyte and sometimes as a weak parasite on stored organs of plants. The fungus continues to grow inside the tissues. When the epidemis breaks, the fungus emerges through the wounds and produces aerial sporangiophores, sporangia, stolons, and rhizoids, the latter capable of piercing the softened epidermic (Agrios, 1997).

In the spring of 2000, a rhizopus soft rot occurred on Squash (*Cucurbita moschata*) grown in greenhouses in Chinju area. The infection rate of the disease in some greenhouses reached to 28.6% and the damage was quite severe.

The infected area of fleshy organs appeared water-soaked at first, then softened. Fungal hyphae grew outward through the wounds and covered the affected portions by producing tuft whiskerlike gray sporangiophores and sporangia (Fig. 1A, B). The infected organs finally broke down and disintegrated in watery rot (Fig. 1C).

Diseased fruits were collected from Squash (cv. Aehobag) grown in greenhouses and causal organism was isolated. From mycelial tip on disease fruits, brownish black fungal colonies were isolated and cultured on potato dextrose agar. This fungus was incubated in the dark at 20°C. Sporangium, sporangiospores and sporangiophores were carefully observed under the light microscope (Nikon Fluophot, Japan). The mycelial growth and germination of sporangiospores of the fungus at various temperatures were examined.

Colonies on potato dextrose agar at 25°C were white cottony at first and then becoming heavily speckled with the presence of sporangia and the brownish black, spreading rapidly by stolons at various points to the substrate by rhizoids (Fig. 2D). Size of sporangia was 125.3 × 294.2 (av. 195.7 µm). globose or sub-globose with somewhat flattened base. Sporangiophores were 2.7-6.8 × 12.9-33.9 µm, smooth-walled, non-septate, light brown, simple, long, arising in groups of 3-5 from stolons opposite rhizoids (Fig. 2A). Sporangiospores were 8.6-21.1 × 6.4-11.7 µm, irregular, round, oval, elongate, angular, brownish-black streaked (Fig. 2B). Columella were 63.8 × 140.4 µm, light brownish gray, hemispheric, umberella-shaped when dehisced (Fig. 2C, Table 2). The maximum temperature for mycelial

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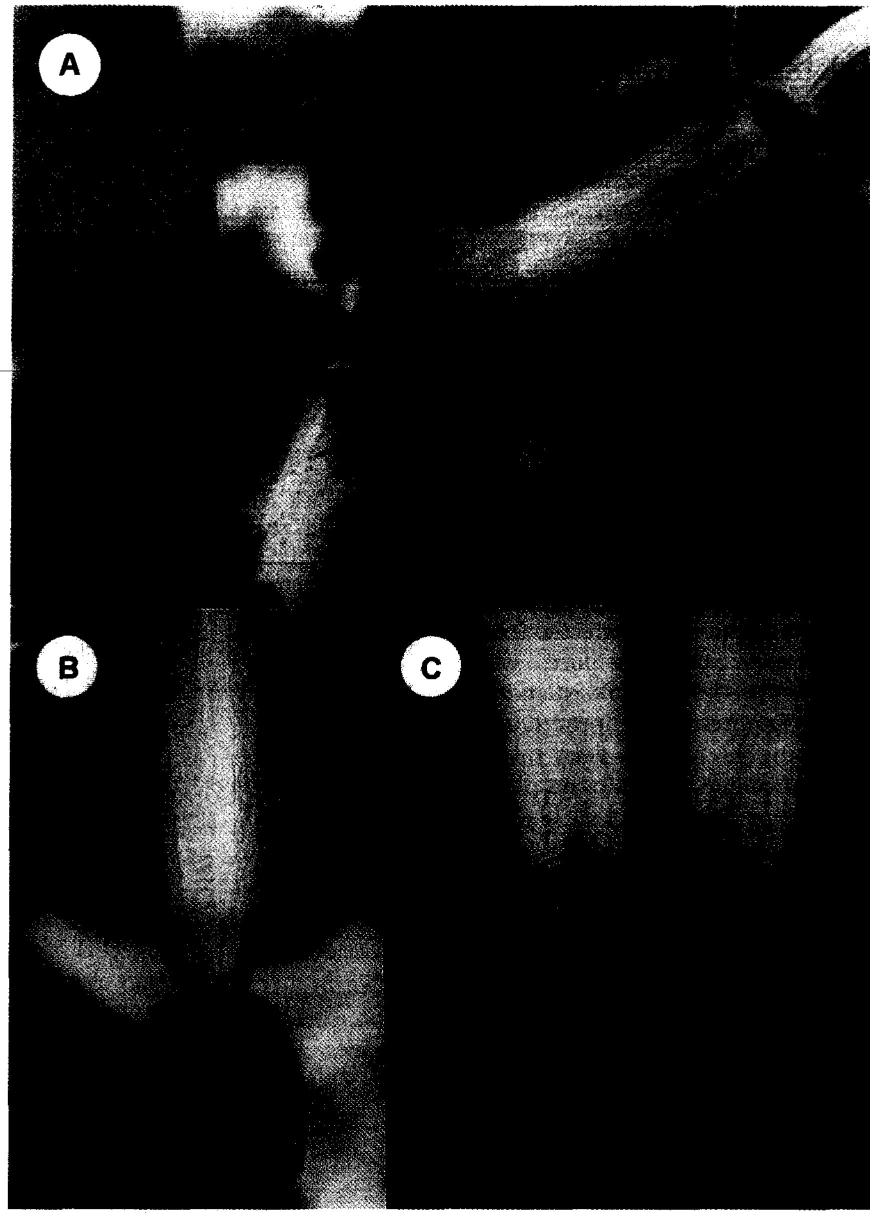

Fig. 1. Symptoms occurred on squash flower and fruits. A: Infected flower; water-soaked symptom started from petals or peduncle, then withering whole floral parts and dense mycelia and sporangia were formed. B: Infected fruits; Symptoms usually started from the blossom end, then spread up ward, C: Longitudinal section of infected fruit. Early infected parts were sunken, collapsed, and soft rotted.

growth was 35°C. The minimum growth temperature was 5°C. Optimum growth temperature was 25°C (Table 1).

Above characteristics are almost identical to *Rhizopus stolonifer* (Ehrenberg ex. Fr.) Lind. All of the isolates on fruits successfully induced the typical symptoms of rhizopus soft rot on squash. The typical symptoms were appeared 4 days after inoculation with spore suspension. The symptoms were identical to those of naturally infected host plants. Morphological characteristics of conidia and mycelia of the fungi that were reisolated from inoculated plants were same as those of naturally infected fruits.

Unfavorable temperature and humidity or immaturity of the fruit depressed the growth and activity of the fungus. The rhizopus soft rot of pepper (*Capsicum annuum* L.) have been reported in Korea (The Korea society of plant pathology, 1998), but no records of disease on squash (*C. moschata*) in Korea (Cho et al., 1997). The rhizopus soft rot disease in papaya, vinca rosea, grape and pear have been reported in many countries (Alvarez et al., 1997; Farr et al., 1995; Harris et al., 1987; Lisker et al., 1996; Yasuda et al., 1999). But the disease were not reported on *Cucurbita* L. (Farr et al., 1995).

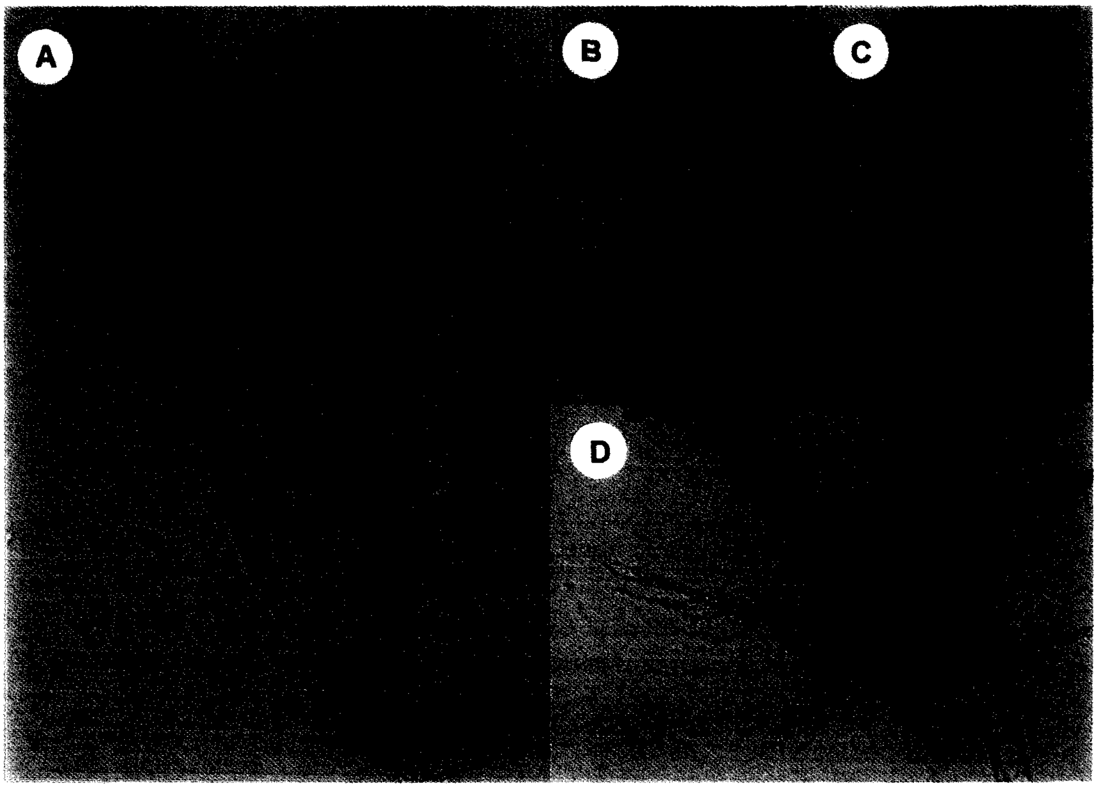

Fig. 2. Morphology of the causal organism, *Rhizopus stolonifer.* A: Sporangia and sporangiophores, B: Sporangiospores, C: Typical columella, D: Rhizoid and stolon.

Table 1. Effect of temperature on mycelial growth of *Rhizopus stolonifer* isolated from rotten squash (*Cucurbita moschata*)

	Temperature (°C)							
	5	10	15	20	25	30	35	40
Colony diameter (mm)[a]	10.0	22.6	42.6	83.3	90.0	20.7	10.2	0.0

[a]Diameter of mycelial growth was measured after 2 days of incubation of the fungus on PDA. The data are mean of three replications.

Table 2. Comparison of mycelial characteristics of the pathogenic fungus isolated from rhizopus soft rot of squash (*Cucurbita moschata*) with Lind's description of *Rhizopus stolonifer*

Characteristics		Present isolate	*R. stolonifer*[a]
Colony	color	white to brownish	white to brownish
Sporangiospores	size	8.6-21.1 μm	10-20 μm
Sporangiophores	size	2.7-6.8 × 12.9-33.9 μm	3-5 × 13-25.3 μm
Sporangia	shape	globose, sub-globose	globose, sub-globose
	size	125.3 × 294.2 μm	85-200 μm
Columella	size	63.8 × 140.4 μm	70-90 μm

[a]Described by Lind's (1913).

Generally, squash (*C. moschata*) is cultivated in greenhouses or vinyl houses near to urban area where frequently keep high temperature and humid condition. Such environments are favorable for occurring rhizopus soft rot of squash. To prevent squash plant from rhizopus soft rot, the temperature and humidity in the canopy of squash plant should be controlled properly and avoid the wounding in fresh fruits and stems.

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