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Phytophthora Rot on Sword Bean Caused by *Phytophthora nicotianae*

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***Phytophthora* rot on sword bean, *Canavalia gladiata*, which has not been reported yet in Korea, occurred in some fields of Jinju in 2003. The disease develops on the basal stem of the plant, but is also often observed on leaves and pods. Rot lesions begin with small dark brown spots and as these are water-soaked, they enlarge rapidly. The magnitude of at the field reached 40%. Abundant sporangia of *Phytophthora* were formed on the surface of diseased pods and were mummied later. The causal fungus was identified as *P. nicotianae* with the following mycological characteristics: Sporangium- readily formed in water, papillate, noncaducous, ovoid to spherical, 24-58 (L) × 22-35 (W) in size; Oogonium- spherical, smooth walled, and 22-30; Oospore- aplerotic, spherical, and 18-24; Antheridium- amphigynous, unicellula, and spherical; Chlamydospore- abundant, spherical, and 25-35; Sexuality- heterothallic, and A1 or A2; Optimum growth temperature- about 28°C. The fungus showed strong pathogenicity to sword bean. Symptoms similar to those observed in the fields appeared 2 days and 4 days after inoculation with and without wound on pods. This is the first report of *Phytophthora* rot of sword bean in Korea.**

Keywords : Phytophthora rot, *Phytophthora nicotianae*, sword bean

The sword bean (*Canavalia gladiata* DC), an annual climbing legume, is considered as a healthy food material being used for fermented or functional food in Korea. Although the plant has been cultivated for a long time in the country, its practical use became popular only recently and cultivation acreage also enlarged accordingly. As the cultivation acreage increased, new or unrecorded diseases occurred on the plant.

However, only a sooty mold caused by *Cladosporium cucumerinum* was recorded by the authors (Kwon et al., 2000; The Korean Society of Plant Pathology, 2004) and other important diseases damaging the plant have not been studied much yet.

Phytophthora is known to be one of the most destructive plant pathogen groups which attacks most cultivation crops worldwide (Erwin and Ribeiro, 1996; Jee et al., 2000). In Korea, 18 species of *Phytophthora* infecting 70 host plants have been reported. However, no *Phytophthora* diseases on legumes, except *P. sojae* on soybean, have been reported in the country (Jee et al., 1998; Jee et al., 2000).

Sword beans severely infected by *Phytophthora* sp., other than *P. sojae*, were brought to our laboratory by a farmer. The disease infected up to 40% of the sword beans in a few fields at Jinju. Symptoms were observed not only on pods but also on leaves, stems, and roots. In this study, the causal pathogen of the sword bean pod rot was identified and its pathogenicity to the plant was confirmed.

Materials and Methods

Field survey and pathogen isolation. The *Phytophthora* rots on sword beans were investigated in the fields located at Munsan, Jinju in 2003. The disease was mainly observed on pods and leaves, and a litter on other parts of the plants such as stems, roots, flowers, and flower stalk. Freshly infected plant parts were collected from the fields and cut into small pieces for isolation of the causal pathogen. The small pieces sized 5 × 5 mm were disinfected in 1% NaClO solution for 30 sec and incubated on both Jee's *Phytophthora* semi-selective medium and water agar for 48 hr at 25°C (Jee et al., 1998; 2000). Mycelia growing out from the diseased tissues were cut and transferred to 10% V8 juice agar for further study.

Characterization of the pathogen. Cultural and colony patterns of the pathogen were observed on potato dextrose agar after incubation for 7 days at 25°C. Sexual and asexual reproduction structures of the pathogen were examined on 10% V8 juice agar. After incubation for 4 days at 25°C, actively growing mycelia were cut into small blocks, 10 × 10 mm, and submerged in distilled water for sporulation. Sporangia were examined under a microscope after incubation with light for 24 hr in the water. Mating types of the isolates were determined by dual culture with standard mating type isolate either A1 or A2 supplied by the Institute of Agricultural Science and Technology. Morphological characteristics of chlamydospores and oospores which were formed on the medium, as described above, were examined under

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a microscope at 100 or 200 ×.

Pathogenicity test. Zoospores were used as an inoculum for the pathogenicity test. Mycelial blocks, ca. 10 × 10 mm, were made from 4 day-old cultures of 10% V8 agar, and 20-30 agar blocks were transferred to new petri dishes containing 20 ml of distilled water. The plates were incubated under a fluorescent light for 24 hr at 24°C for sporulation. The plates were chilled for 30 min at 4°C for zoospore release from sporangium. Zoospores were harvested by filtering with four layers of cheesecloth and adjusted to 10^4/ml. Sword bean plants grown in pots for 120 days were

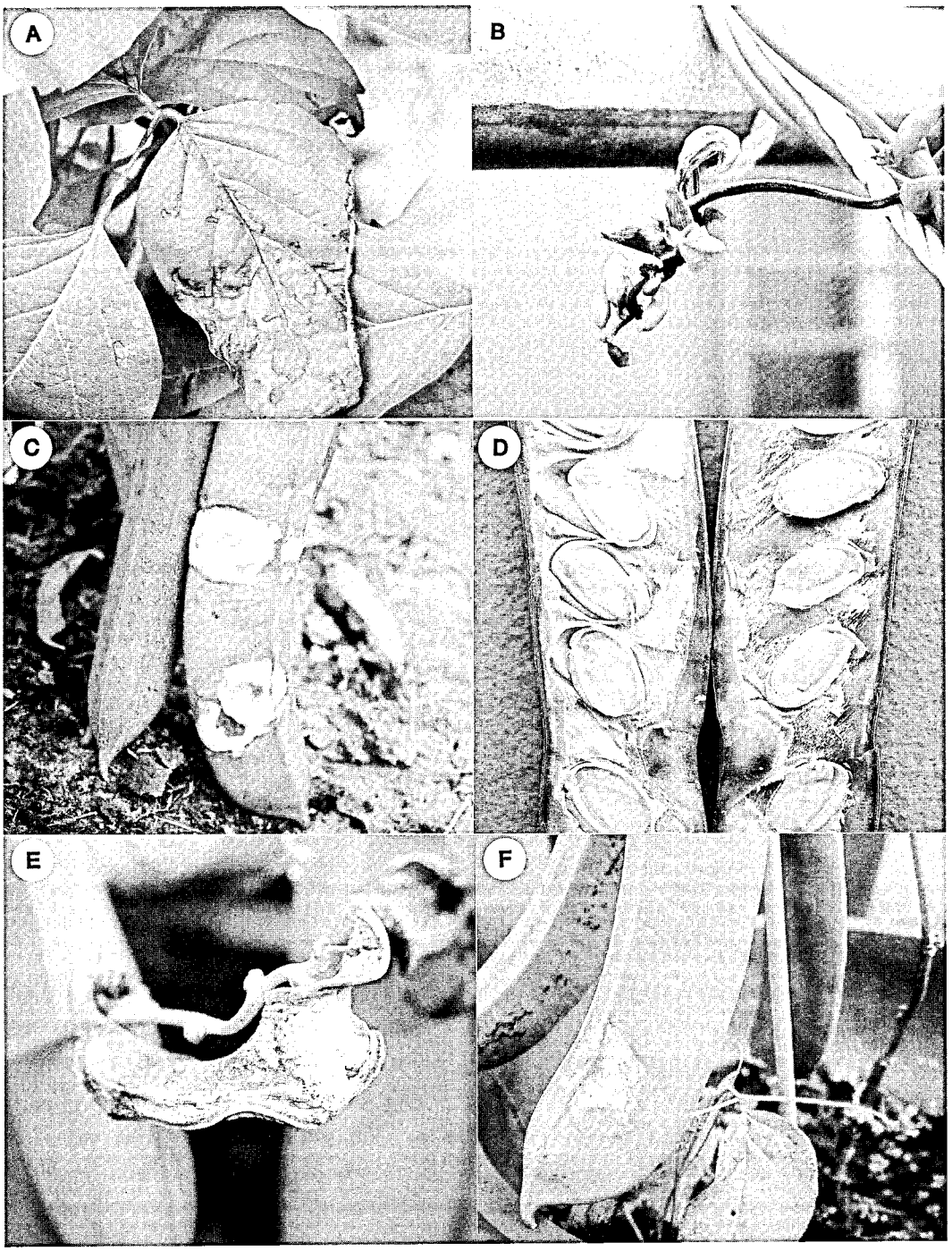

Fig. 1. Symptoms of the *Phytophthora* rot on sword bean caused by *Phytophthora nicotianae*. **A**: Irregular lesions appeared on a leaf and petiole, **B**: Symptoms on flower, calyx, and flower stalk, **C**: A typical symptom on pod. White mycelia are abundantly growing on surface of the pod, **D**: An inside and outside symptoms of pod caused by natural infection, E: A mummified pod at late stage of infection, F: A symptoms on pod caused by artificial inoculation.

used. Both wounded (by using a pin) and not wounded pods were fully sprayed with the inoculum and kept in a growth chamber that supplied 100% moisture for 24 hr.

Results and Discussion

Symptoms. Phytophthora rots occurred on all parts of sword bean such as pods, leaves, stems, vines, flowers, petioles and roots. On leaves, water-soaked brownish irregular spots appeared and enlarged along the veins. The whole leaves were blighted eventually (Fig. 1A). Rots on vines or petioles of pods enlarged longitudinally and upper parts of the lesions were dried later (Fig. 1B). White mycelial mats were formed on and inside the infected pods under humid conditions in the fields. The water-soaked pods became mummified eventually (Fig. 1C, E). Longitudinal section (Fig. 1D) shows inside and outside symptoms of pod caused by natural infection. Pods produced near soil line were infected more often than those formed on the upper vines of the plant. Abundant sporangia of the pathogen were often produced on surface of infected pods which may play an important role as the secondary inoculum source attacking aerial parts of the plants.

Cultural conditions. Sword bean seeds were sown in pots in late March, transplanted in early April, and cultivated through October in fields. The disease lesions, appearing as dark brown rots, were first observed in late May at the basal stems. The lesions gradually girdled the stems until the whole plant became severely wilted. The disease spread rapidly during the rainy season and became an epidemic in the heavily infected field. In July, the disease spread to aerial parts of leaves, pods, and vines, and these were picked in August after the rainy season.

Mobility of Phytophthora, a semi-aquatic fungus, depends largely on water (Jee et al., 2000; Erwin and Ribeiro, 1996). Accordingly, long rainy days and high rainfall cause the disease to spread rapidly. In Jinju area, rainy days in May, June, July, and August 2003 were 10, 9, 24, and 16 days; respectively. The rainfall in those months were 293.0, 259.6, 481.0, and 343.0 mm; respectively. This unusual

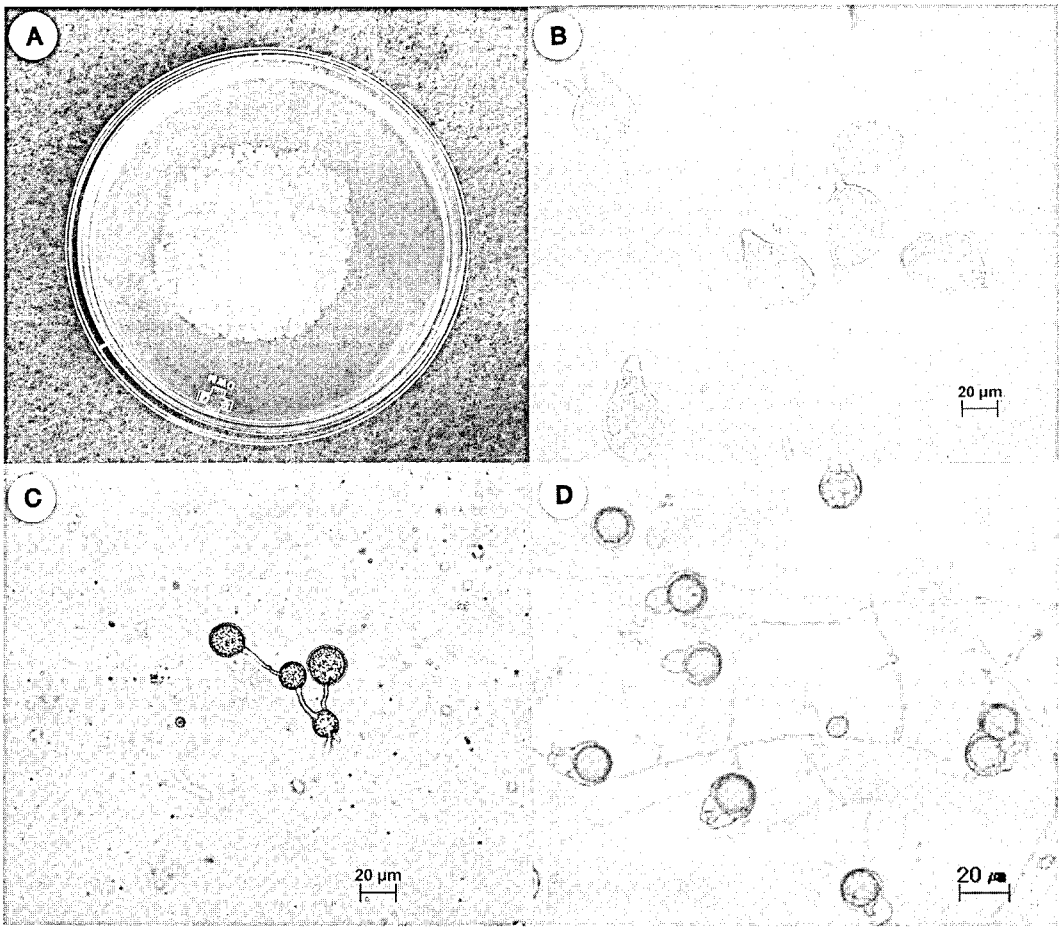

Fig. 2. Morphological characteristics of *Phytophthora nicotianae,* the causal agent of sword bean rot. Colony morphology on PDA represents arachnoid growth pattern (**A**), Ovoid or sperical sporangia (**B**), Intercalary or terminal chlamydospores (**C**), and Oospores (**D**).

Table 1. Comparison of mycological characteristics of the *Phytophthora* causing sword bean rot and *Phytophthora nicotianae*

Characteristics		Presented isolated	*P. nicotianea*[a]
Colony		arachnoid or rosaceous	dense or loose rosette
Sporangium			
	shape	papillate, noncaducous, ovoid to spherical	papillate, noncaducous, ovoid to spherical
	size	24-58 × 22-35 μm	28-66 × 20-48 μm
Sporangiophore		branched	branched
Oogonium			
	shape	spherical, smooth wall	spherical, smooth wall
	size	22-30 μm	24-34 μm
Oospore			
	shape	aplerotic, spherical	aplerotic, spherical
	size	18-24 μm	18-34 μm
Antheridium		amphigynous, unicellula, spherical	amphigynous, unicellula, spherical
Chlamydospore			
	shape	abundant, spherical	abundant, spherical
	size	25-35 μm	18-50 μm
Sexuality		heterothallic	heterothallic
Hyphal swelling		formed on agar and water	formed on agar and water

[a] Described by Breda de Haan (1896).

weather conditions in the area favored and caused *Phytophthora* rot epidemics on sword bean.

Identification of the causal pathogen. Colony of the isolate on PDA showed typical arachnoid pattern that is one among the distinctive cultural characteristics of *Phytophthora nicotianae* (Jee, 1998; Jee et al., 1998; 2000, Han et al., 2001, Lim et al., 2004). The fungi grew at temperatures of 7-38°C, with an optimum of 28-30°C (Fig. 2A). However, the fungal growth was relatively slow at 3.5-4.5 mm/24 hr at 25°C. Sporangia were produced both on agar and in water, however, they were formed more abundantly in water than on agar. Most sporangia were globose to ovoid, rarely caducous, and sized 24-58(L) × 22-35(W) μm (Fig. 2B). Globose chlamydospores were also readily produced intercalary and terminal of aged culture on 10% V8 juice agar and sized mostly 25-35 μm (Fig. 2C). Sexuality of the isolates were heterothallic, since oospores were formed only when mated with A2 mating type culture. Oospores were aplerotic and 20-24 μm in size. Small and spherical antheridia were attached to oogonium amphigynously (Fig. 2D).

Based on the distinctive mycological characteristics such as cultural pattern, sporangial shape, oospore size, and sexuality, the causal pathogen of sword bean was identified as *P. nicotianae*. The fungal characteristics examined in this study fitted with those described by Erwin and Ribeiro (1996) and Jee et al. (1998, 2000).

Pathogenicity. When zoosporagial suspensions of a representative isolate were sprayed on the pod of the plant, symptoms similar with those observed in the field appeared 2 or 4 days after, with or without wounds (Fig. 1F). The first symptom of water-soaked lesions appeared on pods were observed. The rot lesions enlarged on the whole pods within 7-10 days. The same pathogen inoculated on the pods were readily re-isolated from the fresh lesions. To our knowledge, this is the first report of *Phytophthora* rot on sword bean caused by *P. nicotianae* in Korea.

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