

Stem Rot of Carnation Caused by *Fusarium oxysporum* and *Rhizoctonia solani*

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*Fusarium oxysporum*과 *Rhizoctonia solani*에 의한 카네이션 줄기썩음병

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ABSTRACT: Incidence of stem rot on carnation (*Dianthus caryophyllus* L.) ranged 11 to 29% in Namwon and Chongup area during the growing seasons from 1993 to 1994. Among 129 isolates from carnations in Namwon, 77 isolates were identified as *Rhizoctonia solani*, 38 isolates were *Fusarium oxysporum* and 14 isolates were not identified. Among 169 isolates in Chongup, 19 isolates were identified as *R. solani*, 106 isolates as *F. oxysporum* and 44 isolates were not identified. Among 77 isolates of *R. solani* isolated from the specimens of Namwon, 52 isolates were classified as anastomosis group AG 2-2 by anastomosis test, 14 isolates as AG 2-1 and 11 isolates as AG 4. Among 19 isolates from specimens of Chongup, 14 isolates were classified as anastomosis group AG 2-2 and 5 isolates as AG 4. Pathogenicity tests revealed that isolates of *F. oxysporum* and *R. solani* AG 2-2 were highly virulent and isolates of *R. solani* AG 2-1 and AG 4 were mildly virulent.

Key words: Stem rot, Carnation, *Fusarium oxysporum*, *Rhizoctonia solani*.

A stem rot which was similar to Fusarium wilt (7) caused by *Fusarium oxysporum* was encountered in carnation fields during a survey of Fusarium wilt. Stem rot (11), wilt (7, 10), root rot (2) and bacterial stunt (8) has been reported as systemic wilt diseases of carnation in other countries. Fusarium wilt caused by *F. oxysporum* f. sp. dianthi, root rot caused by *F. roseum* f. sp. cerealis and stem rot caused by *Rhizoctonia solani* was reported on the compendium (11, 12) in Korea. Usually Fusarium wilt is soilborne plant disease that cause serious problems in carnation but *R. solani* was more frequently isolated from the stem rot symptoms than *F. oxysporum* in Namwon area. Isolates of *R. solani* have been classified into different three anastomosis groups in pathogenicity (11). There have been no studies on

anastomosis grouping for *R. solani* isolates from carnation in Korea. In this study, frequency of *F. oxysporum* and *R. solani* isolated from diseased stem of carnation collected from Namwon and Chongup areas was surveyed and isolates of *R. solani* were grouped by anastomosis test and their pathogenicity was investigated.

MATERIALS AND METHODS

Field survey. Carnation fields were surveyed in Namwon, Chongup during the growing season from 1993 to 1994. An incidence rate of stem rot was encountered as rate of infected plants and infected stems were collected for isolation of pathogenic fungi.

Isolation and identification. Isolation was conducted according to the method of Kim *et al.* (1). Nine

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to 16 mm² pieces cut from the diseased carnations were plated on 2% water agar after surface-sterilizing with 1% sodium hypochlorite solution for 1 min. *Rhizoctonia* sp. and *Fusarium* sp. were isolated from the lesion pieces after incubation at 25°C for 1~2 days. The isolates were transferred to potato dextrose agar (PDA) slants for identification. *R. solani* was identified based on the morphological and cultural characteristics according to the classification of Parmeter and Whitney (6,9) and *F. oxysporum* was identified according to the method of Nelson *et al.* (3).

Anastomosis test. All isolates of *R. solani* from the diseased carnations were tested for anastomosis grouping. Each isolate was paired with the standard isolates of *R. solani* AG-1 to AG-8 obtained from Tokyo University, Japan. Anastomosis test was accomplished by method indicated by previous workers (4, 5).

Inoculum. Each isolates of anastomosis groups AG 2-1, AG 2-2, AG 4 of *R. solani* and *F. oxysporum* were used for pathogenicity test to carnation. *R. solani* isolates were cultured in PDBR medium (100 ml of potato dextrose broth and 38 g of buckwheat rice) in a 500 ml-flask and isolates of *F. oxysporum* were cultured in V-8 juice agar medium at 25~28°C for 14 days.

Pathogenicity test. Carnation cultivars Desio and Castellaro were used for pathogenicity test. Inocula-

tion to carnation was performed in three replicates in a greenhouse at 15~30°C. Seedlings of each cultivar were planted in a plastic pot with sterile soil and cultured for 30 days in the greenhouse. Inoculation to the carnation was performed by putting 20 g of each inoculum (*R. solani*) and 10 g of shattered *F. oxysporum* into the pots. The pots inoculated with *R. solani* were placed in a vinyl-tunnel (25~30 °C) for 5 days and the pots inoculated with *F. oxysporum* were placed in a greenhouse. Virulence rating was made 14 days to 30 days after inoculation.

RESULTS

Disease incidence and symptoms. Incidence of stem rot on carnation ranged from 11 to 29% in the fields at the two locations during the growing seasons from 1993 to 1994 (Table 1).

Symptoms appeared as a rot of stems and roots of carnations in the field. The interfascicular parenchyma of infected stems discolored to brown and wilted at early growing stage. The root rot also appeared in the late growing stage. A Fusarium wilt sign was shown at the host epidemics which caused by *F. oxysporum*.

Isolation and anastomosis group. Among 129 isolates from carnations in Namwon, 77 were identified as *R. solani*, 38 were identified as *F. oxysporum* while 14 isolates were not identified. Among 169 isolates in Chongup, 19 were identified as *R. solani*, 106 as *F. oxysporum* but 44 isolates were not identified. *R. solani* was more frequently isolated in Namwon than Chongup (Table 2).

Among 96 isolates of *R. solani* collected from Namwon, 66 were classified as anastomosis group AG 2-2 by anastomosis test, 14 as AG 2-1 and 16 isolates as AG 4. *R. solani* AG 2-2 was more frequently

Table 1. Incidence of stem rot on carnation in fields at two locations from 1993 to 1994

Location	Cultivar	Investigated fields ^a	Infection rate (%)	
Namwon	Desio	A	14	
		B	19	
		C	11	
		D	23	
	Castellaro	A	27	
		B	19	
Chongup	Lawhurella	A	13	
		B	15	
	Lemina	A	11	
		B	18	
	Aster 2,000	A	19	
		Orian	A	29
		Crana	A	21

^aTwo hundred plants in each field were investigated in three replicates.

Table 2. Frequency of fungi isolated from diseased stems of carnation collected from two locations

Location	Fungi isolated		
	<i>Rhizoctonia solani</i>	<i>Fusarium oxysporum</i>	Unidentified fungi
Namwon	77	38	14
Chongup	19	106	44

Total collected specimens were 129 and 169 from Namwon or Chongup area, respectively. Each denominator are isolated fungi.

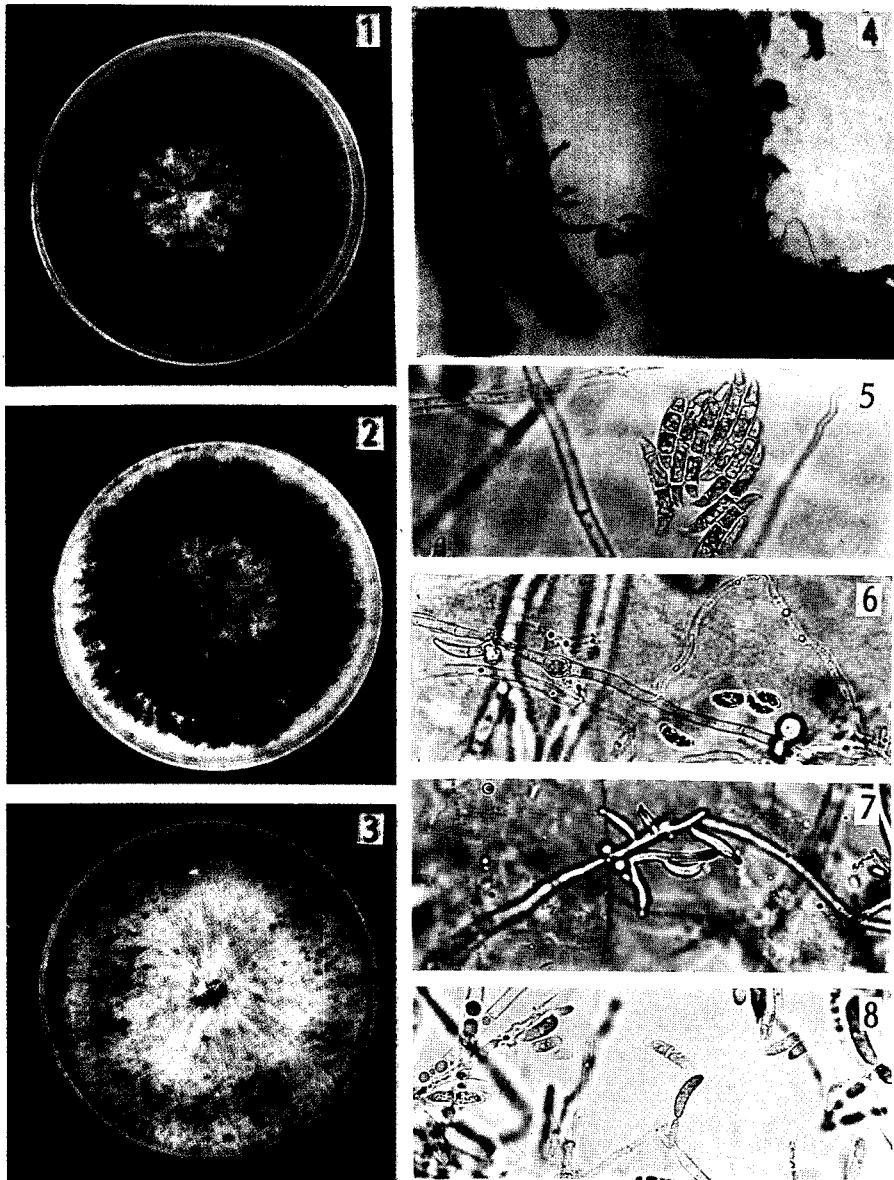


Fig. 1. Symptom of stem rot caused by *Rhizoctonia solani* (left) or *Fusarium oxysporum* (right) on carnation (4). Colony on Potato Dextrose Agar, *R. solani* AG 2-1 (1), AG 2-2 (2) and AG 4 (3). *F. oxysporum*: macroconidia (5), chlamydospores (6), macroconidiophores (monophialides) (7), microconidiophore (monophialide) and microconidia (8).

isolated than AG 2-1 and AG 4 in both locations.

Pathogenicity. Symptoms appeared in the infected carnations by artificial inoculation with *R. solani* and *F. oxysporum* isolates. Symptoms caused by *R. solani* was appeared at the stem nearby roots (Fig. 4, left) and the symptoms caused by *F. oxysporum* appeared at the upside stem (Fig. 4, right). Pathogeni-

city tests revealed that the isolates of *F. oxysporum* and AG 2-2 were highly virulent. Isolates of AG 2-1 and AG 4 were mildly virulent.

DISCUSSION

R. solani AG 2-1, AG 2-2, AG 4 and *F. oxysporum*

Table 3. Anastomosis groups of *Rhizoctonia solani* isolates from diseased stems of carnation

Anastomosis group	No. of isolates at location	
	Namwon	Chongup
AG 2-1	14	—
AG 2-2	52	14
AG 4	11	5

were associated with the occurrence of stem and root rot of carnation. Among the isolates, *R. solani* was more frequently isolated from the sample showing a stem rot symptoms in Namwon area, but *F. oxysporum* was more frequently isolated in Chongup. Among the anastomosis groups, AG 2-2 was most frequently isolated and virulent to carnation. A stem rot of carnation caused by *R. solani* has been one of the important recurring problems in Hawaii (11) and Fusarium wilt caused by *F. oxysporum* has been one of the important recurring problems in the Netherlands (7). Bacterial stunt and root rot of carnation caused by *Pythium irregulare* and *P. aphanidermatum* cause serious problems in Japan (2). It is difficult to distinguish between symptom of stem rot caused by *R. solani* and symptom of Fusarium wilt caused by *F. oxysporum* at late stage. Trujillo *et al.* (11) reported that *R. solani* AG 2-2 was highly pathogenic to carnation, while AG 2-1 and AG 4 were not pathogenic. The present study revealed that *R. solani* AG 2-2 was most pathogenic to carnation and AG 2-1 and AG 4 were weakly pathogenic. It is concluded that *F. oxysporum* was the major causal fungi to carnation in Chongup and *R. solani* AG 2-2 was the major causal fungi of stem rot in Namwon. Susceptibility to *R. solani* and *F. oxysporum* between *Dianthus caryophyllus* L. cv. *Desio* and *D. caryophyllus* L. cv. *Castellaro* was not different. An integrated control method about stem rot and Fusarium wilt are needed.

요 약

1993년 6월부터 1994년 5월까지 전북 남원과 정읍지역의 비닐하우스내 포장에서 재배되고 있는 카네이션 줄기썩음병의 발생율은 11~29%였다. 남원 지역에서 채집한 129개 이병주로부터 77균주의 *Rhizoctonia solani*가 분리 되었고, *Fusarium oxysporum*도 38균주 분리되었다. 정읍지역에서 채집한 이병주로

Table 4. Pathogenicity of *Fusarium oxysporum* isolates and *Rhizoctonia solani* isolates by artificial inoculation to carnation

Fungus inoculated	Isolate No.	Virulence of isolates on cultivars	
		Desio	Castellaro
<i>F. oxysporum</i>	F-1	++ ^a	+
	F-2	++	++
	F-3	++	++
<i>R. solani</i> AG 2-1	R-2-1-1	+	+
	R-2-2-2	+	—
	R-2-3-3	+	+
<i>R. solani</i> AG 2-2	R-2-2-1	++	++
	R-2-2-2	++	++
	R-2-2-3	++	++
<i>R. solani</i> AG 4	R-4-1	+	--
	R-4-2	+	+
	R-4-3	+	+

^aVirulence rating was made 30 days after inoculation. ++: Above 60% of rotted plants, +: 30~59% of rotted plants, -: no symptom.

부터는 *F. oxysporum*이 106균주, *R. solani*가 19균주 분리되었다. 남원지역에서 분리된 *R. solani* 77균주를 균사융합 검정 결과 52균주는 AG 2-2, 14균주는 AG 2-1 그리고 11균주는 AG 4로 분류되었다. 정읍지역 으로부터 분리된 19균주 중 14균주는 AG 2-2로, 5균주는 AG 4로 분류되었고, AG 2-1은 분리되지 않았다. 분리된 *F. oxysporum*과 *R. solani*의 각 균사 융합균별 병원성은 *F. oxysporum*과 *R. solani* AG 2-2는 강한 병원성을 나타내었고, AG 2-1과 AG 4는 병원성이 약한 것으로 나타났다.

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