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DETERMINATION OF FUSARIUM SPECIES IN CARNATION GREENHOUSES IN ANTALYA, TURKEY

AYDIN ATAKAN AND HÜLYA ÖZGÖNEN ÖZKAYA

ABSTRACT. In this study, revealing of the identification and pathogenicity of *Fusarium* species isolated in carnation greenhouses of Antalya, Turkey were aimed. As a result of isolations, fungi included in *Fusarium* genus were identified using macroscopic and microscopic techniques. Pathogenicity of identified species were determined using Turbo carnation cutivar. As a result of the diagnostic studies, species belonging to the genus *Fusarium* were determined as *F. acutatum, F. avenaceum, F. chlamydosporum, F. equiseti, F. oxysporum, F. poae, F. proliferatum, F. sambucinum, F. solani, F. tricinctum* and *F. verticillioides*. *F. oxysporum* is the most commonly isolated species According to the pathogenicity test in Turbo carnation variety, the disease severity of *Fusarium* species were changed between 60-88 % and determined that *F. solani* had the highest pathogenicity rates among the others. Consequently, a total of 11 *Fusarium* species have been identified and has been demonstrated that have potential to cause problem in carnation cultivation in greenhouses in Antalya, Turkey.

1. INTRODUCTION

Turkey has a very wide variety of ecological vegetation and floristic features [1]. The economic importance of ornamental plants has been increasing in many countries, and international demand has quickly expanded. Carnation have an importance in basic ornamental crops, because it is the main export products particularly in the Antalya Province in Turkey. Carnation has a wide range of colors and patterns and is one of the rare flowers that decorate floral bouquets and it has

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been exported to many countries around the World. One of the most important factors limiting the carnation production and causes of losses are fungal diseases in Turkey.

Fungi spread in the ecosystem as parasites, pathogens and saprotrophic [2,3]. Among the important diseases of the upper parts are *Alternaria dianthi* F. Stevens & J.G. Hall and *Uromyces dianthi* (Pers.) Niessl. lead to significant losses in carnation greenhouses. However, it is reported that the most important losses are caused by soil-borne fungi, especially *Fusarium* species [4,5]. *Fusarium* genus is the most important group among soil-borne pathogens causing diseases in carnation and other ornamental plants. It is reported that *Fusarium* spp. lead to root and stem rot, wilt and plant deaths [6]. The most common species isolated from carnation greenhouses is *Fusarium* spp. in Antalya, Turkey [7]. The most important fungal pathogen causing root rot and wilt in carnation is *F. oxysporum* Schl. f. sp. *dianthi* W.C. Snyder & H.N. Hans [8,9]. In a study conducted in Iran, *F. proliferatum* (Matsush.) Nirenberg and *F. solani* (Mart.) Sacc. were reported as the first records of carnation, and the pathogenicity tests revealed that the virulence of *F. solani* was higher than *F. proliferatum* [10].

The aim of this study was to determine *Fusarium* spp. from infected plants in carnation greenhouses in Antalya Province. In addition, the pathogenicity tests were conducted using Turbo carnation cultivar and determined the effects on plant growth parameters. This is the first detailed study determining *Fusarium* species in this field where carnation production is made.

2. Materials and Methods

2.1 Collection of plant samples and pathogen isolation

Carnation samples showing disease symptoms (yellowing, wilting) were collected from a total of 29 carnation greenhouses in Antalya Province, Turkey. Collected plant samples were placed in plastic bags, taken to the laboratory, and subjected to isolation procedures.

For isolation procedure, the roots were cleaned and washed under running tap water and excess moisture was taken on the filter paper. For isolation, 4-5 mm tissue pieces were cut from the plant parts to containing diseased and healthy tissues and sterilized in 2% sodium hypochloride solution for 2 minutes. The surface sterilized plant parts

were rinsed twice with sterile distilled water and excess moisture were dried on sterile fitler papers. The sterilized tissues were placed in each petri dish containing the Potato Dextrose Agar (PDA) medium and incubated for 7 days at 24 °C. After the purification, *Fusarium* spp. were cultured on PDA, Carnation Leaf Agar (CLA) [11], Synthetic Nutrient Agar (SNA) [12].

2.2 Identification of *Fusarium* species

For the identification of *Fusarium* species, the isolates were cultured on PDA, SNA and CLA and than, incubated at 25 °C for 7-10 days. Colony diameters were measured at the end of the 4^{th} days development period and the daily growth rate was calculated. The lam culture technique was used to diagnose *Fusarium* cultures. The prepared lam cultures were incubated at 25 °C for 5-15 days [13]. Hyphal branching, fialid, microconidia, macroconidial shapes and sizes, chlamydospore and sporodochium formation of *Fusarium* species were observed using light microscope (Nicon/Eclipse E 100). During microscopic observations, for each species microconidia and macroconidia dimensions were measured with 10x and 40x objectives.

2.3 Determination of Pathogenicity of *Fusarium* species

The pathogenicity tests of *Fusarium* species were determined with pot trials in healthy carnation plants (*Dianthus caryophyllus* Linn. cv. Turbo). Rooted carnation plants were planted in pots with 10 cm diameters including peat and were grown in the climate room (16 hours of light, 8 hours of dark conditions, at 20 °C and 60-70% relative humidity. A selected isolate of each species was cultured on autoclaved wheat culture in 9 cm diameters petri dishes. Plants were inoculated by placing three grams of inoculum around roots. The control plants were inoculated three grams of autoclaved wheat cultures without pathogens in the experiments.

Pathogenicity of *Fusarium* species were evaluated according to scale 1-5 (1: Healthy plant; 2: Chlorosis in the bottom parts of the plant; 3: Bottom parts of the plant and 1/3 of the chlorosis or wiltness; 4: Wiltness on the upper part of the plant; 5; dead plant) [14]. At the end of the trial period, shoot length were measured with a ruler to evaluate the effects of pathogens on plant growth. At the same time, shoots and root weights are determined.

2.3 Statistical Analysis

The obtained data were analyzed by using variance analysis program of Minitab and the differences among the averages were determined by Tukey ($p<0.05$) multiple comparison test [15].

3. Results

In the present study, plant samples showing disease symptoms were collected and isolated from 29 carnation greenhouses in Antalya Province. As a result of surveys, a total of 11 *Fusarium* species have been identified and it has been proved that these species are potential problem in carnation production areas.

Species identified according to the morphological characteristics have been *F. acutatum* Nirenberg & O'Donnell, *F. avenaceum* (Fr.) Sacc., *F. chlamydosporum* Wollenw. & Reinking, *F. equiseti* (Corda) Sacc., *F. oxysporum* Schl., *F. poae* (Peck) Wollenw., *F. proliferatum* (Matsush.) Nirenberg, *F. sambucinum* Fuckel, *F. solani* (Mart.) Sacc., *F. tricinctum* (Corda) Sacc. and *F. verticillioides* (Sacc.) Nirenberg. Among the identified *Fusarium* species, *F. acutatum, F. avenaceum, F. chlamydosporum, F. poae, F. sambucinum* and *F. tricinctum* have been isolated for the first time in carnation, Turkey. The species having the highest and lowest prevalance were determined as *F. oxysporum* and *F. chlamydosporum*, respectively.

The pathogenicity of all *Fusarium* species in Turbo carnation cultivar were determined and the species had disease severity (%) at varying rates. The most virulent species were determined as *F. solani, F. sambucinum, F. oxysporum* and *F. acutatum.*

3.1 Cultural and Morphological Characteristics of *Fusarium* Species

Fusarium species isolated from carnation greenhouses of Antalya Province were identified by classical methods according to their cultural and morphological characteristics (Table 1).

TABLE 1. Distinctive features of *Fusarium* species

Fusarium species	Daily development rate on PDA(cm)	Pigmentation on PDA	Chlamydospor formation	Microconidia		Number of septa in macroconidia	Types of conidiogenous cells		Apical cell	Basal cell shape	Macroconidia sizes (µm)
				Shape	Number of septae		Monofialide	Polyfialide			
F. acutatum	1.1	Orange	+*	Oval Fusiform-Allantoid	0	3	+	+	Curved	Foot shape	30-54x2-3,5
F. avenaceum	1.2	Yellowish Brown	+	Fusiform	0-3	4-7	+	+	Smooth sickle	Foot shape	35-90x3,5-6
F. chlamydosporum	1.75	Burgundy	+	Smooth-Comma	0-2	3-5	+	+	Short curved-pointed	Foot shape Notched	30-37,5x3-5
F. equiseti	1.3	Brown	+	-	-	3-5-7	+	-	Alongated tapered	Foot shape	15-60x2,5-5,9
F. oxysporum	1,3	White-Violet	+	Oval Elipsoid Cylindrical	0-2	3-5	+	-	Curved	Foot shape	20-50x3-6
F. poae	1.5	Yellow- Red	-	Napiform Pyriform	0-1	2-3	+	-	Curved Tapered	Foot shape	18-38x3,8-7
F. proliferatum	1.1	Cream-Violet	-	Clavate Pyriform	0-1	3-5	+	+	Curved	Foot shape	30-58x3,3-4,4
F. sambucinum	1.1	Cream-Brown Red	+	-	-	3-5	-	+	Needle-tipped	Foot shape	22-50x4-5,6
F. solani	0.9	Brown - Orange	+	Clavate Ellipsoid	0-2	3-5	+	+	Alongated curved	Foot shape Notched	27-65x4,4-6,8
F. tritinctum	1.1	Red -Violet	+	Oval Pyriform Sitriform	0-1	3-5	+	+	Tapered Curved	Foot shape	24-50x3,2-4,6
F. verticilloides	1.2	Greyish cream-Violet	-	Oval-Clavate	0-2	3-7	+	-	Tapered Curved Needle-tipped	Foot shape Notched	30-58x2,7-3,6

* (+) available, (-) absent

F. avenaceum (Corda : Fr.) Sacc

The colony diameter was measured as 3-5.9 cm at 25 °C on the SNA medium at 4th days. *F. avenaceum* forms abundant aerial mycelium and its colour varies from yellow to whitish red. The pigmentation on the PDA is yellowish or brownish red. Conidiophores arising from aerial mycelium are simple, more or less branched. The microconidia in conidiogenous cells are fusiform shaped, 0-3 septate, and 6-30 x 2.5-4.5 (6) µm in size. Macroconidia are formed massively, it's fusiform-shaped, narrow in both sides, 4-7 septate, mostly 35-89 (90) x 3,5-4 (6) µm in size. Chlamydospores don't occur in mycelium, but they are rarely formed in the conidia. *F. avenaceum* causes root rot in wheat, rye, alfalfa and rough alfalfa. At the same time it leads to damage in vegetables, peach, apple, pear, oat, barley and wheat seeds [17,18] (Figure 2).

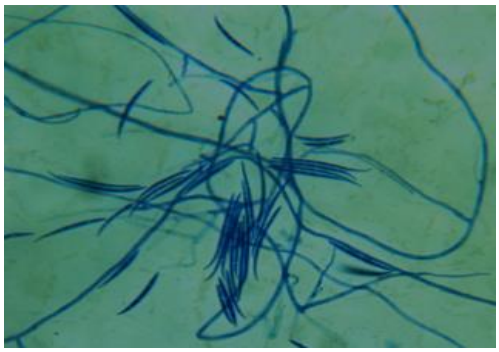

FIGURE 2. *F. avenaceum* macroconidia

F. chlamydosporum Wollenweber & Reinking

The colony diameter was measured as 7 cm at 25 °C on the PDA medium at 4th days. The aerial mycelium is white in young cultures. As the culture ages, its colour changes into greyish or burgundy. Microconidia are smooth or comma shaped, usually 0-2 septate, 10-26 x 2.5-4 µm in size. Microconidia are abundant and they are produced on both mono and poliphialides. Sporodochia formation is rare in PDA. In CLA, when sporodochia is produced, it is usually hidden on the bottom surface of carnation leaves. Macroconidia are thick walled and moderately curved. Macroconidia are usually 3-5 septate and have dimensions of 30-37.5 x 3-5 µm. Chlamydospore formation is abundant and very fast on CLA. Chlamydospores can be formed both singly and as a chain or bulk [19, 20]. (Figure 3)

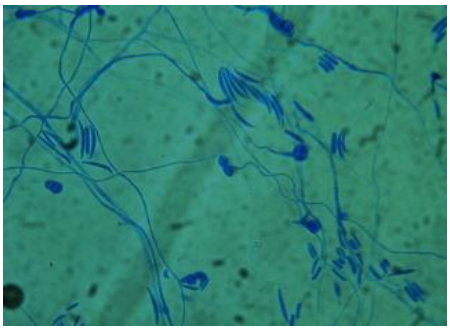

FIGURE 3. *F. chlamydosporum* macroconidia

F. equiseti (Corda) Sacc.

The colony diameter was measured as 4.5-6.9 cm in the 4th days at 25 °C on the PDA medium. The aerial mycelium varies from cream to yellowish brown in older cultures. In some isolates, sporodochia formation can be observed. Agar pigmentation of *F. equiseti* ranges from light brown to dark brown tones or it is formed peach colored pigments. Although microconidia are rare, it may be formed in some isolates fusoid or ovoid shaped, 0-2 septate and 6-24 x 2.5-4 µm in size. Macroconidia are sickle-shaped and they have 3-5 and rarely 7 septate. Dimensions of macroconidia are 15-60 x 2,5-5,9 µm. It produces abundant amounts of chlamydospores. Chlamydospores are formed in thin or thick-walled, intercalated, single, chain or clustered in hyphae and conidia [18]. (Figure 4)

FIGURE 4. *F. equiseti* macroconidia

F. oxysporum Schl.

The colony diameter was measured as 3-5.5 cm at 25 °C on the PDA medium at 4th days. The aerial mycelium has a cottony appearance and its whitish or peach colored. The pigmentation in the agar varies from cream to burgundy. In some races, orange colored sporodochia can be formed. Monophialides consist of branched or unbranched conidiophores. Microconidia are usually 0-2 septate, oval, ellipsoidal, cylindrical, smooth or slightly curved and 5-12 x 2.2-3.5 µm in size. They are formed in abundant amounts in short-branched phialides. Macroconidia are 3-5 septate, fusiform shaped, slightly curved, prominent in apical and basal cells and (20)27-46(50) x 3-4,5(6) µm in size. Chlamydospores are formed on hyphae or conidia, thin or thick-walled, semi-spherical shaped, terminal or intercalar of 5-15 µm in diameter. Chlamydospores can occur in both single and chain forms [18, 19]. (Figure 5)

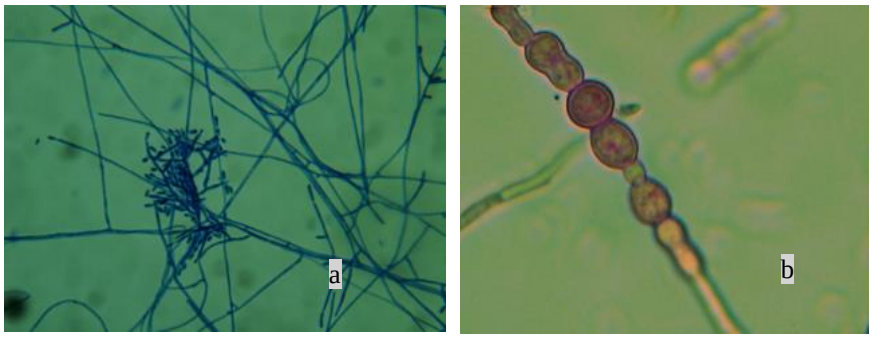

FIGURE 5. (a) *F. oxysporum* phialides, (b) chlamydospores

F. poae (Peck) Wollenw.

The colony diameter was measured as 5.5-8.8 cm at 25 °C on the PDA medium at 4th days. The aerial mycelium is cottony white or pale pink and may be close to the purple on the surface of the agar. Culture releases a scent that similar to peach smell. The pigmentation on the agar varies from yellow to shaded red. Sporodochia formation is not available. Microconidia formed in abundant amounts are napiform or pyriform shaped and their sizes are between 6-10 x 5.5-7.5 µm. Macroconidia are slightly curved, mostly 2-3 septate and 18-38 x 3,8-7 µm in size. Some macroconidia are 5 septate and bigger than 56 µm. Chlamydospore formation is absent, but hypha swellings are seen in some cultures. It has been reported to be isolated from cereal seeds, pepper and bean [18, 21]. (Figure 6)

FIGURE 6. *F.poae* macroconidia

F. proliferatum (Matsush.) Nirenberg

The colony diameter was measured as 3.5-5.5 cm at 25 °C on the PDA medium at 4th days. Color of aerial mycelium is white, pale pink or grayish violet. It can form a black sclerotium. Microconidia, produced in abundant amounts of aerial mycelium, are usually 0-1 septate. It is produced as a long chain or in conidiophores in bulk. The clavate-shaped ones are 7-9 x 2.2-3.2 μm and the pyriform-shaped ones are 7-11 x 4.7-7.7 μm. Macroconidia are rarely produced, usually 3-5 septate, smooth or sickle shaped and have dimensions of 30-46 x 3,3-4,1 μm, - 47-58 x 3,4-4,4 μm, respectively. There is no chlamydospore formation [18, 19]. (Figure 7)

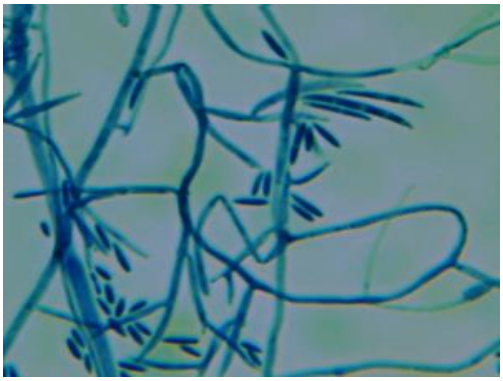

FIGURE 7. *F. proliferatum* macroconidia and microconidia

F. sambucinum Fuckel

The colony diameter was measured as 3.4-5.9 cm at 25 °C on the PDA medium at 4th days. The aerial mycelium is cottony and its color varies from white to dried rose. It forms white, yellowish, rosy or grayish red pigment on the agar surface. Dark red pigment is rarely seen in older cultures. It forms spore mass or sporodochia. There are no production of microconidia. Macroconidia are 3-5-7 septate, falcate, curved and thin-walled. Average dimensions of macroconidia are 22-50 x 4-5,6 μm. Chlamydospores occur singly, in the form of a chain, or as a mass [18, 19]. (Figure 8)

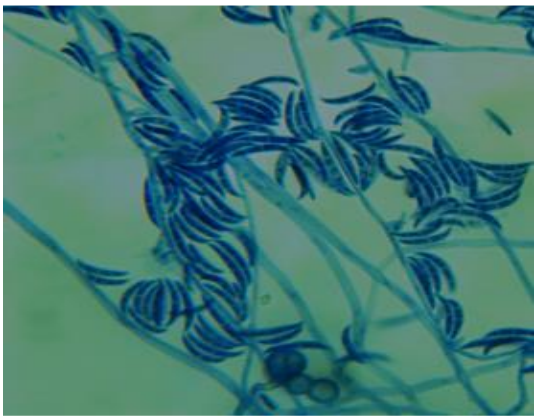

FIGURE 8. *F. sambucinum* macroconidia

*F. solani (*Mart.) Sacc.

The colony diameter was measured as 2.5-5.0 cm at 25 °C on the PDA medium at 4th days. The aerial mycelium is sparse or dense and its colour varies from greenish white to cream. Sometimes, on the surface of the agar forms a bluish-brown pigment from green. The conidial mass are also composed of sporodochia. Monophialides emerge from branched or unbranched conidiophores. Microconidia are generally ovoid, 0 to 1 septate and 8-16 (24) x 2-4 (5) µm in size and consist of long conidiophores with verticillate branching. Macroconidia are 3 to 5 septate (usually 3 septate) fusiform, cylindrical, slightly curved shaped and 27-52 (65) x 4.4-6.8 µm in size. The foot cell has a short apical cell that is not evident. Shape of chlamydospore varies from globose to ovoid and it forms hypha or conidia. Chlamydospores can form in terminal, intercalary, or chain form. Among the hosts were reported in carnations, avocados, beans, citrus, pea, peppers, potatoes and squash [18, 19, 21]. (Figure 9)

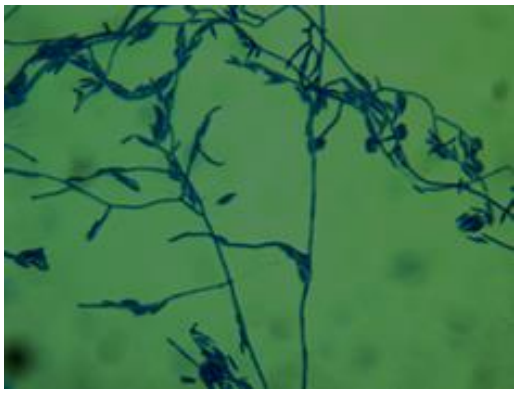

FIGURE 9. *F. solani* phialid and microconidia

F. tricinctum (Corda) Sacc.

The colony diameter was measured as 3.2-5.5 cm at 25 °C on the PDA medium at 4th days. The aerial mycelium is in a tight and fluffy form, and the color changes from red to purple, with the upper layer of these colors covered by a pale white mycelium. The agar color is generally red and purple tones, but in some cultures it produces yellowish pigment. Monophialides that are thin (10-30 x 2-3µm) and no simpodial branching are emerged from too many branched conidiophores. Microconidia are 0 to 2 septate, usually citriform, pyriform, napiform, ellipsoid or fusiform shaped, and 8-11 (14) x 4,5-7,5 µm in size. Sporodochium also produces a large number of macroconidia. Macroconidia are moderately curved and usually 3 to 5 septate and its dimension range from 24-46 x 3,2-4,1 µm to 33-50 x 3,6-4,6 µm. Chlamydospore formation is not common. It has been reported to be isolated from carnations, red alfalfa, cereals and soil [18, 19]. (Figure 10)

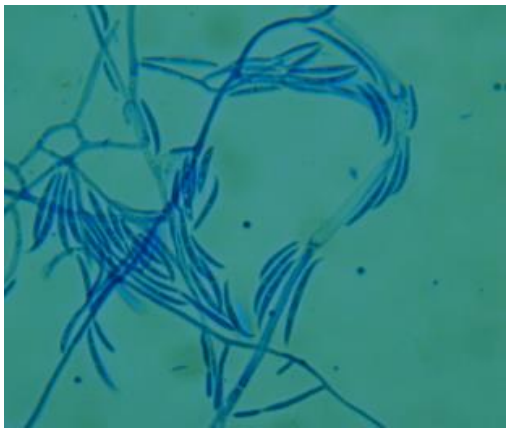

FIGURE 10. *F. tricinctum* macroconidia

F. verticillioides (Sacc.) Nirenb.

The colony diameter was measured as 3.5-5.5 cm at 25 ° C on the PDA medium at 4th days and 6.2 cm diameters in the 10 days on the SNA medium [9]. Microconidia are produced abundantly in aerial mycelium. It forms dark violet, lilac, wine red or shaded cream pigment on the agar surface. Microconidiophores are usually on aerial mycelium and don't show branching. The microconidia are in the form of long chains, rarely stacked, 0-2 septate, clavate shaped, with dimensions of 4.3-19 x 1.5-4.5 µm. Sporodochium and macroconidia are rarely seen in many races. Macroconidiophores show lateral and verticillate branching on hyphae. Macroconidia are thin, 3-7 septate smooth or slightly curved, fusiform, thin-walled, curved, apical cell elongated and basal cell stalked form. Sizes of macroconidia range from 30-46 x 2,7-3,6 µm to 47-58 x 3,1-3,6 µm. Chlamydospore formation is absent [18, 19]. (Figure 11)

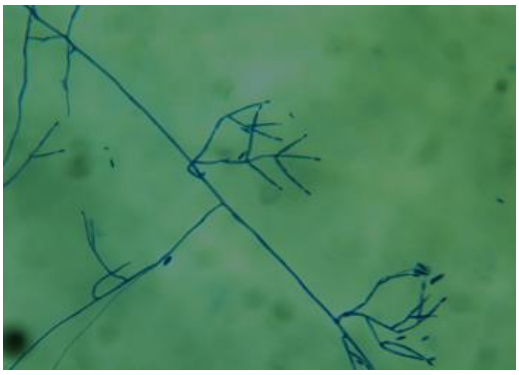

FIGURE 11. *F. verticillioides* phialid and microconidia

3.2 Pathogenicity Test

Pathogenicity tests of the identified *Fusarium* species were performed using Turbo carnation cultivar. According to the results, *Fusarium solani* had the highest disease severity, which was determined as 88%, followed by *F. acutatum* and *F. oxysporum* with 80% and 76% disease severity, respectively (Table 2).

TABLE 2. Disease index and disease severity after inoculation of *Fusarium* species (%)

***Fusarium* species**	**Disease Index**	**Disease Severity (%)**
F. acutatum	4.0 a*	80
F. avenaceum	3.2 b	64
F. chlamydosporum	3.2 b	64
F. equiseti	3.4 b	68
F. oxysporum	3.8 b	76
F. poae	3.0 c	60
F. proliferatum	3.4 b	68
F. sambucinum	4.2 a	84
F. solani	4.4 a	88
F. tricinctum	3.0 c	60
F. verticillioides	3.2 b	64

* The averages containing different letters in the same column are statistically different from each other according to the Tukey ($p<0,05$) test.

In this study, *F. solani, F. acutatum, F. sambucinum* and *F. oxysporum* significantly affected plant development in pathogenicity tests carried out at 25 ± 2 °C that they may cause serious problems in the production areas of carnation in our country. The inoculated *Fusarium* species were re-isolated from the infected carnation plants to prove the Koch's postulates.

According to the pathogenicity tests which conducted 28 days later, *Fusarium* species have reduced root weight, root length, shoot weight and shoot length compared to control (Table 3).

TABLE 3. Effect of *Fusarium* species on plant growth parameters

Pathogen	Root weight (g)	% Reduction	Root length (cm)	% Reduction	Shoot weight (g)	% Reduction	Shoot length (cm)	% Reduction
K**	3.01 a*	-	7.30 a	-	12.52 a	-	45.0 a	-
Fa	0.84 bc	71.9	1.62 b	77.8	2.93 b	76.6	7.6 c	83.1
Fav	0.54 bc	82.0	1.78 b	75.6	3.23 b	74.2	9.8 bc	78.2
Fc	0.61 bc	79.9	1.60 b	78.1	2.72 b	78.2	11.0 bc	75.6
Fe	0.98 bc	67.4	1.98 b	72.9	2.38 b	81.0	9.4 bc	79.1
Fo	0.81 bc	73.1	1.94 b	73.4	3.32 b	73.5	11.0 bc	75.6
Fp	1.02 b	66.3	1.54b	78.9	4.24b	66.1	12.0 bc	73.3
Fpr	0.94 bc	68.9	1.64 b	77.5	3.51 b	71.9	10.0 bc	77.8
Fs	0.92 bc	69.5	2.00 b	72.6	2.78 b	77.8	7.4 c	83.6
Fso	0.78 bc	74.0	1.88 b	74.2	2.31 b	81.5	8.6 bc	80.9
Ftr	0.69 bc	77.2	1.40 b	80.8	4.00 b	68.0	8.0 bc	82.2
Fv	0.79 bc	73.7	1.98 b	72.9	2.57 b	79.5	8.0 bc	82.2

* The averages containing different letters in the same column are statistically different from each other according to the Tukey ($p<0,05$) test.
** K: Kontrol, Fa: *F. acutatum*, Fav: *F. avenaceum*, Fc: *F. chlamydosporum*, Fe: *F. equiseti*, Fo: *F. oxysporum*, Fp: *F. poae*, Fpr: *F. proliferatum*, Fs: *F. sambucinum*, Fso: *F. solani*, Ftr: *F. tricinctum*, Fv: *F. vericillioides*

Fusarium species have reduced root and shoot lenghts by 72.6-80.8 % and 73.3-83.6 % respectively, compared to control. *F. verticillioides, F. solani, F. sambucinum, F. oxysporum*, and *F. equiseti* have brought about a reduction of 72.6-74.2% in root lenght. The other *Fusarium* species have caused more than 75 % reduction in root lengths. Pathogens have reduced root and shoot weight by 66.2-82 % and 66.1-81.5

%, respectively. While the greatest decline in root weight was made up by *F. avenaceum*, the greatest loss of shoot weight was caused by *F. solani.*

4. Discussion

From identified *Fusarium* species; *F. acutatum, F. avenaceum, F. chlamydosporum, F. poae, F. sambucinum* and *F. tricinctum* have been isolated for the first time in carnation, Turkey.

F. avenaceum has been reported to be pathogenic in watermelon, sainfoin, sugar beet and cotton. In a previous study, *F. chlamydosporum* was reported in spinach, watermelon, tomato and cucumber. *F. equiseti* has been reported to be pathogenic in carnation, gladiolus, tulip, melon, watermelon, cotton, tomato, onion, barley, wheat, chickpea, rice, bean, cabbage, carnivorous, spinach, radishes and celery, *F. oxysporum* was reported to be pathogenic in crops such as carnation, gladiolus, tulip, hyacinth, freesia, melon, watermelon, cucumber, chickpea, lentil, tomatoes, pepper, rice, cabbage, cauliflower, cowpea, cucumber, broom, corn, linen, groundnut, soybean, pea, bean, cotton, , banana, potato, onion, citrus fruits, apple and beet, *F. sambucinum* was reported to be pathogenic in crops such as tomato, pumpkin, cucumber, onion, cabbage, cauliflower, spinach, melon, watermelon, okra, lettuce, radish, carrot, cucumber, sunflower, sesame and tobacco, *F. proliferatum* was reported in carnation, wheat, bean, sainfoin, melon, watermelon and onion [21]. Among the hosts of *F. solani* were reported in carnation, avocado, bean, citrus, pea, pepper, potato and squash [18, 19, 21]. *F. tricinctum* was reported to be pathogenic in crops such as wheat, corn, cotton, pepper, eggplant, beet, onion and tomato, *F. verticillioides* was reported to be pathogenic in crops such as carnation, cereals, pomegranate and citrus [21].

In a conducted study in the Istanbul Province and its around, Özer and Soran [22] reported that *F. equiseti* was pathogenic by 70 % in carnation. In a conducted study in the Yalova Province, the pathogenicity of the Tempo carnation cultivar of *Fusarium* spp. isolated from carnation was determined. This resulted in virulence of *F. oxysporum* 76.70 %, *F. moniliforme* 100 %, *F. solani* 56.70 % and *F. culmorum* 66.70 % [23]. McCain [4] reported that *F. oxysporum* and *F. tricinctum* led to the disease in the carnation.

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Current Address: Aydın ATAKAN (Corresponding author)*: Gaziantep University, Department of Plant and Animal Production, Gaziantep, Turkey*
E-mail :aydinatakan@gantep.edu.tr
ORCID: https://orcid.org/0000-0001-9794-4427

Current Address: Hülya ÖZGÖNEN ÖZKAYA; *Isparta University of Applied Science, Department of Plant Protection, Isparta, Turkey*
*E-mail :*hulyaozgonen@isparta.edu.tr
ORCID: https://orcid.org/xxxxxxxxxxxxxxxx