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PATHOGENIC VARIABILITY OF *FUSARIUM OXYSPORUM* F. SP. *CICERIS* ISOLATES FROM CHICKPEA IN TURKEY

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Abstract

The isolates of *Fusarium oxysporum* f. sp. *ciceris*, representing eight provinces located in four regions of Turkey were analyzed for pathogenic variability on a set of 10 differential cultivars of chickpea viz., JG 62, C 104, JG 74, CPS 1, BG 212, WR 315, Annigeri, Chafa, L 550, 850-3/27. All isolates were identified as races 0, 2 and 3. Races 0 and 2 were widely found among the isolates representing Black Sea, Aegean and Mediterranean regions. Races 0 and 3 were found in chickpea growing areas of South Eastern Anatolia region. This study is the first extensive research for determination of race distribution of *Fusarium* wilt isolates obtained from the important chickpea growing areas in different regions of Turkey. These data will be useful in breeding programmes of chickpea cultivars resistant to *Fusarium* wilt.

Introduction

Fusarium wilt caused by *Fusarium oxysporum* Schlechtend.: Fr. f. sp. *ciceris* (Padwick) Matuo & K. Sato, is an important fungal pathogen restricting chickpea production in many countries. The pathogen results in major economic losses ranging from 10-40% worldwide (Nene *et al.,* 1984; Kaiser *et al.,* 1994). The use of resistant cultivars is the most effective and practical mean to control *Fusarium* wilt (Nene & Haware, 1980; Bakhsh *et al.,* 2007; Mahmood *et al*., 2011). However, pathogenic variability in different growing areas complicates control measures to the pathogen and causes the heavy losses. Variation in aggressiveness of *F. oxysporum* isolates has been characterized into two pathotypes associated with the yellowing or wilt disease syndrome of chickpea (Trapero-Casas & Jiménez-Díaz, 1985). Also, 8 races of *F. oxysporum* f. sp. *ciceris* have so far been reported based on disease reactions of differential lines. Races 1A, 2, 3, and 4 were reported from India and races 0, 1B/C, 5, and 6 from USA (CA) and Mediterranean region (Haware & Nene, 1982; Phillips, 1988; Jiménez-Díaz *et al.,* 1993; Halila & Strange, 1996). Races 1A, 2, 3, 4, 5, and 6 cause the wilting syndrome while races 0 and 1B/C cause the yellowing syndrome (Jiménez-Díaz *et al.,* 1993). Little information is known about the pathogenic variability of *F. oxysporum* f. sp. *ciceris* isolates on chickpea in Turkey. Dolar (1997) reported the existence of races 0, 2 and 3 in Ankara province of Turkey. The objective of the present study was to determine the pathogenic variability of *Fusarium* wilt isolates in different chickpea growing areas of Turkey.

Materials and Methods

Fungal and plant materials: All isolates used in this study were selected among the isolates obtained from different provinces of Turkey in a previous study and deposited in our culture collection. The isolates and their locations are shown in Table 1. A set of 10 differential chickpea lines (JG 62, C 104, JG 74, CPS 1, BG 212, WR 315, Annigeri, Chafa, L 550, 850-3/27) used to determine races of *F. oxysporum* f. sp. *ciceris* was provided by Teresa Milan at Cordoba University and multiplied in the fields of Ankara University to get enough seeds for the studies.

Table 1. The location and race distribution of *Fusarium oxysporum* f. sp. *ciceris* isolates used in this study.

Isolate	Region	Province	Race
Ama-1	Black Sea	Amasya	2
Ama-2		Amasya	2
Tok-1		Tokat	0
Tok-2		Tokat	2
Küt-1	Aegean	Kütahya	0
Küt-2		Kütahya	2
Uşk-5		Uşak	0
Dez-10		Denizli	0
Dez1		Denizli	0
Bur-3	Mediterranean	Burdur	2
Bur-5		Burdur	0
Km-7		K.Maraş	0
Km-13		K.Maraş	2
Km-9		K.Maraş	0
Km-16		K.Maraş	2
Km-2		K.Maraş	0
Diyar-9	South Eastern Anatolia	Diyarbakır	3
Diyar-16		Diyarbakır	3
Diyar-15		Diyarbakır	0

Pathogenicity tests: All isolates were subjected to the preliminary pathogenicity test on susceptible cultivars ILC 482 to race 0 and JG 62 to the other races. Pathogenicity tests were performed according to the inoculation method of Nene & Haware (1980). The mixtures of sand and chickpea meal (45g sand + 5 g chickpea meal) in 250 flasks were inoculated with 5 plugs (7mm in diameter) from cultures of isolates of *Fusarium oxysporum* grown on potato dextrose agar medium at 23±1°C for 10 days. After incubation for 15 days, inoculum was mixed with 1kg autoclaved soil in 15cm pots. Five seeds were sown in each pot 4 days later and grown for 40 days at 25±1°C with a relative humidity of 30-50% and 14 h photoperiod (light intensity, 297 µE/m/s). Three pots were used for each isolates and all experiments were repeated 2 times. Control plants were grown in a comparable mixture of uninfected and autoclaved soil. The disease reactions were graded as resistant (0–20% wilt), moderately susceptible (> 20 to 50% wilt) and susceptible (> 50% wilt). The race classifications of *F. oxysporum* f. sp. *ciceris* were based

on the reactions of a set of ten differential lines showed in Table 2 (Haware & Nene, 1982; Jiménez-Díaz *et al.,* 1989).

Table 2. Reaction of chickpea differential lines to races of *Fusarium oxysporum* f. sp. *ciceris.*

Line	Race 0	Race 1	Race 2	Race 3	Race 4	Race 5	Race 6
JG 62	R	S	S	M	S	S	S
C 104	M	S	S	R	S	S	S-M
JG 74	R	R	S-M	R	R	S	R
CPS 1	R	R	S	S	M	S	R
BG 212	R	R	S	M	M	R	R
WR 315	R	R	R	S-M	R	R	R
Annigeri	-	S	S	S	S	-	R
Chafa	-	S	S	S-M	S	-	R
L 550	-	S	S	M	S	-	S-M
850-3/27	-	S	M	M	M	-	R

R: Resistant (0-20% wilt); M: moderately susceptible (20-50% wilt); S: Susceptible (>50wilt)

Results and Discussion

Eight races of *F. oxysporum* f. sp. *ciceris* have been identified by their reactions with chickpea lines (Haware & Nene, 1982; Jiménez-Díaz *et al.,* 1993). In this study, a total of 19 *F. oxysporum* f. sp. *ciceris* isolates representing 8 provinces located in 4 regions of Turkey were examined for their pathogenicity on different chickpea cultivar. All isolates showed a large variation in virulence. The isolates of *F. oxysporum* f. sp. *ciceris* were classified into 3 different races (0, 2 and 3) based on disease reaction on a set of 10 differential chickpea lines (Table 1). Race 0 isolates were moderately virulent to cultivar C104, but not pathogenic to the other cultivars. Race 2 was highly pathogenic to all cultivars except cultivar WR 315 and 850-3/27. Race 3 was pathogenic to cultivar WR 315 which is resistant to the other races (Table 2). Among the nineteen isolates tested, races 0 and 2 consisted of 10 and 7 isolates, respectively whereas race 3 was represented by 2 isolates. Races 0 and 2 were detected in different provinces located in Black Sea, Aegean and Mediterranean regions. Races 0 and 3 were found in South Eastern Anatolia region (Fig 1). In a previous study, Dolar (1997) reported the presence of races 0, 2 and 3 in Ankara province, Central Anatolia region. Jiménez-Díaz *et al.*, (1993) detected the existence of races 0 and 1B/C among 5 isolates from Turkey. These results showed the existence of at least 4 different races (0, 1 B/C, 2 and 3) in chickpea growing areas of Turkey.

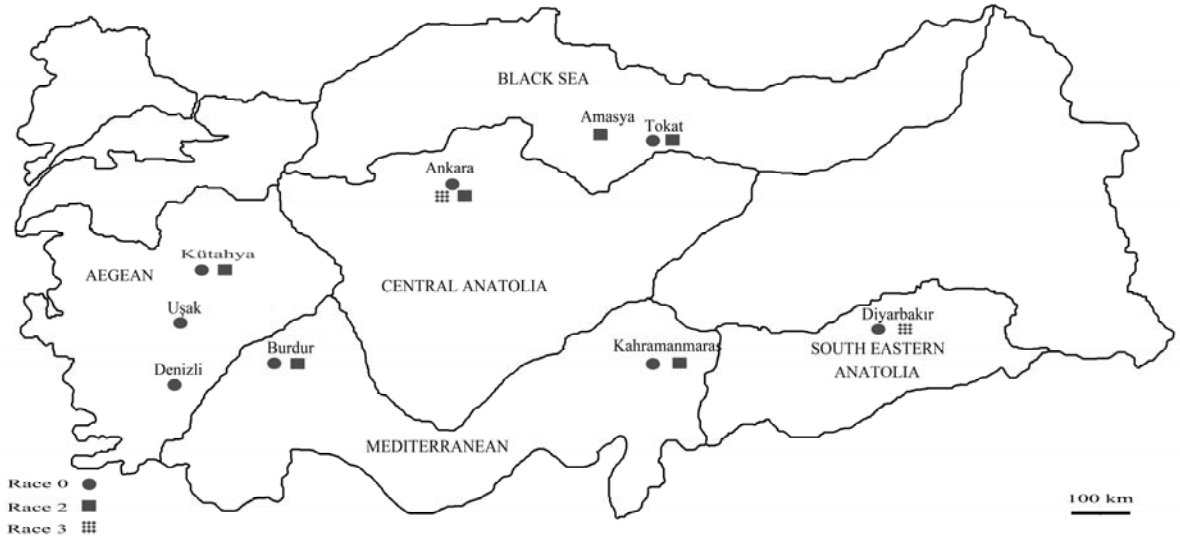

Fig. 1. Map showing geographical location and race distribution of *Fusarium oxysporum* f. sp. *ciceris*. The race distribution in Ankara province was described previously (Dolar, 1997).

Race 0, the least pathogenic of all the races is mainly considered to be adapted kabuli-type chickpea cultivars while the majority of desi-type chickpea cultivars are resistant to race 0 isolates of *F. oxysporum* f. sp. *ciceris* (Jiménez-Díaz *et al.,* 1993; Dolar, 1997). Thus, race 0 was widely found in different regions of the world grown kabuli type of chickpea such as Turkey. Jiménez-Díaz & Trapero-Casas (1990) reported that race 0 is widely distributed in the Mediterranean basin. Race 0 was detected in Spain, United States, Israel, Lebanon, Syria, Tunisia (Jiménez-Díaz *et al.,* 1993; Kelly *et al.,* 1994). Races 1, 2, 3, and 4 were first reported in India (Haware & Nene, 1982). Races 2, 3 and 4 are the most virulent races of 8 races and highly pathogenic to most kabuli and desi-type chickpea cultivars (Haware & Nene, 1982; Jimenez-Diaz *et al.,* 1993). Shehabu *et al.*, (2008) reported the presence of races 0, 2, 3 and 4 in Ethiopia.

Conclusion

The determination of race distribution of *F. oxysporum* f. sp. *ciceris* is fundamental to guide the development of appropriate strategies for disease management according to different regions. However, there are no reports about the determination of *F. oxysporum* f. sp. *ciceris* races in different chickpea growing areas of Turkey except for Ankara province. In this study, the race variability of *F. oxysporum* f. sp. *ciceris* was examined in the important chickpea growing areas of Turkey for the first time. Three different races were determined among the 19 isolates representing 8 provinces. These results will be useful in developing of integrated strategies for diseases management and breeding programs to *Fusarium* wilt.

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