Asian Journal of Plant Pathology 6 (3): 75-80, 2012
ISSN 1819-1541 / DOI: 10.3923/ajppaj.2012.75.80

Response of Jordanian Tomato Land Races to *Fusarium oxysporum* F. sp. *lycopersici*

[1]Mahmoud AL-Khatib, [2]Mohammad Brake, [3]Muien Qaryouti, [1]Khalaf Alhussaen and [4]Hussein Migdadi

[1]Department of Plant Production and Protection, College of Agriculture, Jerash University, Jordan
[2]Department of Science, College of Science, Jerash Univeristy, Jordan
[3]National Centre for Agricultural Research and Extension (NCARE), Jordan
[4]Department of Plant Production, College of Food and Agricultural Sciences, King Saud University, Saudi Arabia

Corresponding Author: Mahmoud AL-Khatib, Department of Plant Production, Faculty of Agriculture, Jerash University, 26150 Jerash, Jordan Tel: 009620777076068

ABSTRACT

This study was conducted under green house conditions during summer growing seasons 2010 and 2011, to evaluate the response of 21 Jordanian tomato land races (accessions) against the vascular wilt fungus *Fusarium oxysporum* f.sp. *lycopersici*. Accessions were provided by the National Center for Agricultural Research and Extension (NCARE). Inoculation with the fungus was carried out by using the root dip method. Parameters considered in this study were discoloration, yellowing and fresh weight. Both discoloration and yellowing were measured, recorded according to 1-5 scale and their results ranged from 1-3.5, while fresh weight ranged from 33.1-76.5 g for treatments compared with 41.0-98.8 g for controls. Nine out of 21 studied tomato accessions were significantly different from other accessions and appeared to be resistant to the fungus under experimental conditions according to the 1-5 scale. Most of the resistant accessions were from the slow growing lines, while most of the fast growing accessions were susceptible. The study concluded that resistant accessions are promising ones to be used as root stocks for cultivated tomato varieties.

Key words: Tomato, land races, *Fusarium oxysporum* f.sp. *lycopersici, Solanum lycopersicum*.L, Jordan

INTRODUCTION

Tomato *Solanum lycopersicum* L. is one of the most widely cultivated crops in the world and is considered as one of the most important cash crops for farmers. It ranks as the second most important vegetable crop next to potato. Present world production exceeds 151 million tons (FAO, 2010). Tomato represents the leading fresh and processed vegetable crop in Jordan with a total area of about 129.6 ha comprising 30.2% of the area of vegetables and producing about 777800 metric tons (Al-Ammah, 2011).

One of the most serious diseases on tomatoes is the vascular wilt disease caused by *F. oxysporum* f.sp *lycopersici*. The fungus causes more economic damage to agricultural crops than any other plant pathogen (Correll, 1991). The fungus moves in infected plants through the root system and grows internally through the cortex to the stele (Bowers and Locke, 2000). It plugs the vascular system resulting in plant wilting (Huang and Lindhout, 1997). Similar to other crop plants, tomato may be infected with Fusarium and Verticillium wilt pathogens (Miller *et al.*, 2001) where, Fusarium wilt, caused by *F. oxysporum* (Schlecht.) f. sp. *lycopersici* (Sacc.), is known as one of the most devastating diseases of tomato worldwide (Mes *et al.*, 1999b).

In Jordan many research pointed that *F. oxysporum* f. sp. *lycopersici* causes vascular wilt disease and spread widely in most tomato growing areas in the country (Mamluk *et al.*,1984; Al-Gazawi, 1988; Abu-Blan, 1995; Al-Khatib, 2004). Al-Khatib (2004) studied the resistance of 24 locally grown tomato varieties to the disease and found that all of them were susceptible to race 2 of the fungus while 50% of the studied varieties were resistant to race 1.

The fungus is known as soil inhabitant and can survive in infested soils for many years (Agrios, 2005). The most effective control measure of the fungus was the use of methyl bromide as soil fumigant but due to global restrictions against the use of methyl bromide and other ozone-depleting substances, farmers tend to use different resistant tomato root stocks to the fungus (Campbell *et al.*, 1982). One of the main sources of these root stocks is the land races or wild cultivars (Edelstein, 2004).

More than 50 land races of tomato were collected and conserved at the gene bank of the National Center for Agricultural Research and Extension (NCARE) in Jordan. The aim of this research was to study the response of these land races to the vascular wilt disease caused by *F. oxysporum* f.sp. *lycopersici*.

MATERIALS AND METHODS

Plant material: Seeds of tomato land races (accessions) were obtained from the (NCARE) and planted in a green house in the farm of Jerash University in summer seasons 2010 and 2011.

Fungal isolates: The vascular wilt fungus *F. oxysporum* f.sp. *lycopersici* was isolated from symptomatic tomato plants from different tomato growing areas in Jordan (Jordan Valley, Jerash and eastern region) in spring and summer 2010. Stem sections from symptomatic plants were taken about 5 cm above the soil level and about 15 cm along the stem, surface disinfested with 0.5% sodium hypochloride (NaOCl) for one minute and cultured on potato dextrose agar media (Marlatt *et al.*, 1996). Susceptible tomato lines (C35) obtained from Jerash Collection Center (JCC), were inoculated with the fungal isolates to maintain aggressiveness of the fungus.

Plant infection and pathogenicity tests: Conidial suspension from 1-week-old cultures isolated on PDA was adjusted to 106 conidia per mL using hemacytometer (Marlatt *et al.*, 1996). Pathogenicity tests were performed by sub-emerging roots of two week-old tomato seedlings in the conidial suspension of the fungus for 5 min, then transplanting the seedlings in pots of peat moss and perlite mixture (1:1 v/v) under greenhouse conditions (Marlatt *et al.*, 1996). Each fungal isolate was used to inoculate 15 plants from each accession and was considered as a treatment. Inoculated accessions of each treatment were transplanted into 4 pots (three plants per pot) and one pot as control (drenched with PDA-water suspension without the fungus). Each pot was considered as a replicate and scoring for each replicate was taken as the average of these three plants in each pot.

Disease severity was assessed weekly (visual observation) starting two weeks after inoculation up to six weeks, were the final estimation was recorded and rated according to 1-5 scale as follows:

1 = No symptoms
2 = Slight chlorosis, wilting or stunting of plant
3 = Moderate chlorosis, wilting or stunting of plant
4 = Severe chlorosis, wilting or stunting of plant
5 = Dead plant

Accessions with average disease ratings grater than 2.5 were considered susceptible (Elias and Schneider, 1991; Marlatt *et al.*, 1996). Plant fresh weight (g plant^{-1}) was taken after last scoring (6 7 weeks after inoculation). Only the above ground part (shoot) was used (Mes *et al.*, 1999a).

Experimental design and data analysis: All treatments were arranged in Randomized Complete Block Design (RCBD) with 4 replicates for each treatment. General Linear Model (GLM) ANOVA (SPSS VER 10) was used to find differences (p = 0.05) between treatment means and control.

RESULTS AND DISCUSSION

Tomato accessions (wild types) in Jordan were found to vary in their reaction towards the vascular wilt fungus *F. oxysporum* f.sp. *lycopersici*. Different parameters were considered in our study including fresh weight, chlorosis and discoloration of the vascular bundles in the stem. According to both, 1-5 scale and fresh weight, 9 accessions out of 21 accessions tested shown resistance to the fungus where 12 accessions were susceptible. Resistant accessions varied in their resistance to the fungus as shown in Table 1. Accession 995 (average fresh weight "f. wt." of rep. 2 was 44.3 g and was significantly higher than that of the control 42.6 g). The same for accession 961 (rep. 1 f. wt. 53.1 g compared with that of the control 48.3 g), accession 979 (f. wt. of rep. 2 and rep. 3 were 64.1 and 64.5 g, respectively compared with that of the control 62.5 g), accession 988 (f. wt. of rep. 1 and rep. 4 were 43.3 and 43.4 g, respectively compared with that of the control 42.2 g) and accession 994a (f. wt. of rep. 3 was 73.5 g compared with that of the control 71.8 g). This indicates high resistance of these accessions compared with other ones and that these accessions are more promising ones. The two parameters were strongly correlated among accessions and were equivalent indicators of accession resistance as shown in Table 1.

A similar study carried by Huang and Lindhout (1997). They screened 17 tomato accessions for resistance to the Fusarium wilt disease and they resulted in three highly resistant accessions that could be used in breeding programs which is one of the aims of our study.

Results showed that all control plants (non treated) from the fast growing accessions (Jo. 952, Jo. 973, Jo. 958, Jo. 974b, Jo. 969, Jo. 959, Jo. 975, Jo. 963 and Jo. 983) differed significantly from treated plants in their fresh weight and were considered to be susceptible to the vascular wilt fungus *F. oxysporum* f. sp. *lycopersici*, where most of the slow or moderate growing ones were resistant to the fungus. Our results were in agreement with Van Ooijen *et al.* (2007) who pointed that resistance proteins in solanaceous plants are correlated with the rate of vegetative growth of these plants. They pointed that fast growing plants result in more susceptibility to plant pathogens which confirms our results. Nawaz *et al.* (2012) studied the interactive effects of different nutrients on tomato yield and disease resistance to early blight caused by *Alternaria solani*. Their results showed that significantly minimum disease incidence (3.67%) than control (17.2%) was recorded in plots which had been treated with phosphorus (100 kg ha^{-1}) and zinc (10 ppm) but without

Table 1: Response of different tomato land races in Jordan towards *F. oxysporum* f. sp. *lycopersici*

		Average Fresh weigh***				
Accession Jo. No.	Discoloration and yellowing**	Rep.1	Rep. 2	Rep. 3	Rep. 4	Control
960	2.7	41.0^{a*}	40.8^{a}	42.4^{b}	41.5^{ab}	48.6^{c}
952	3.2	41.2^{b}	39.4^{a}	40.5^{ab}	39.8^{a}	76.8^{c}
956	2.0	37.5^{a}	39.2^{bc}	40.1^{c}	38.6^{b}	41.0^{c}
995	1.0	42.2^{b}	44.3^{c}	36.9^{a}	42.8^{b}	42.6^{b}
972	2.0	43.4^{a}	47.4^{c}	46.3^{b}	47.6^{c}	48.3^{c}
973	3.5	45.7^{a}	54.3^{b}	54.8^{b}	55.1^{b}	76.8^{c}
961	1.0	53.1^{c}	44.2^{a}	47.6^{b}	48.3^{b}	48.3^{b}
979	1.0	57.3^{a}	64.1^{c}	64.5^{c}	62.3^{b}	62.5^{b}
988	1.0	43.3^{c}	41.4^{ab}	40.6^{a}	43.4^{c}	42.2^{b}
989	1.0	48.7^{b}	46.1^{a}	45.3^{a}	48.9^{b}	49.4^{b}
958	2.8	58.1^{a}	63.5^{c}	60.5^{b}	60.7^{b}	78.8^{d}
974 b	3.2	54.7^{b}	49.4^{a}	65.8^{c}	55.6^{b}	88.5^{d}
994 a	1.5	68.9^{a}	72.2^{bc}	73.5^{c}	71.6^{b}	71.8^{b}
978	2.6	55.1^{ab}	54.2^{a}	60.1^{c}	55.5^{b}	68.8^{d}
969	2.6	66.3^{a}	73.5^{b}	76.5^{c}	72.8^{b}	79.9^{d}
959	3.4	56.2^{a}	65.7^{c}	64.8^{bc}	63.9^{b}	82.6^{d}
975	3.0	63.2^{b}	58.2^{a}	73.9^{c}	64.1^{b}	98.8^{d}
963	3.3	49.7^{a}	62.5^{b}	49.9^{a}	50.1^{a}	95.7^{c}
983	3.0	69.6^{b}	68.9^{b}	64.1^{a}	69.7^{b}	83.2^{c}
984	2.9	33.1^{b}	33.6^{b}	31.3^{a}	34.0^{b}	46.3^{c}
Local cultivar (Rhaba)	1.0	43.8^{b}	45.6^{c}	40.5^{a}	44.3^{bc}	45.0^{c}

*Numbers followed by different letters in the same line are significantly different, **Plants with average ratings greater than 2.5 were considered susceptible. (Each score represents the average of scores of 12 plants), ***Each replicate represents the average weight of three plants, a: No symptoms, b: Slight chlorosis, wilting or stunting of plant

nitrogen. This confirms that increasing speed of vegetative growth of the plant increases its disease susceptibility which is in agreement with our results.

Different previous studies showed that growth rate affects directly susceptibility of tomato plants to the vascular wilt disease. Glala *et al.* (2005) pointed out that cultivars with high vegetative growth were more susceptible to vascular wilt disease caused by *F. oxysporum* f.sp. *lycopersici* compared with those showing low vegetative growth rates.

Another study by Lopez-Berges *et al.* (2010) showed that vascular wilt fungal growth in tomatoes prefers high nitrogen content in the plant. Our results were also confirmed by (El-Kallal, 2007) who pointed out that *F. oxysporum* pathogenized soil inhibits shoot and root growth of tomato plants but it prefers fast growing tomato varieties than low growing ones. Our result were also in agreement with Hawkes and Sullivan (2001). They studied the relation between growth rate and susceptibility to herbivores and pointed that plants grow at low relative growth rate were more tolerant than plants grow at high relative growth rate.

CONCLUSION

The study therefore concluded that accessions Jo. 956, Jo. 995, Jo. 972, Jo. 961, Jo. 979, Jo. 988, Jo. 989, Jo. 994 a and Jo. 984 are considered as promising landraces to be used as tomato root stocks or in breeding programs. The study therefore recommends that, further studies on the reaction of these tomato accessions towards other soil born pathogens are required.

REFERENCES

Abu-Blan, H.A., 1995. Diseases of Plants under Greenhouse Conditions and their Control Measures. 3rd Edn., Al-Dustoor Al-Tejareyyah, Amman, Jordan. (In Arabic).

Agrios, G.N., 2005. Plant Pathology. 5th Edn., Academic Press, New York, USA., ISBN: 13-9780120445653, Pages 922.

Al-Ammah, J.D.I., 2011. Statistical Yearbook. Department of Statistics, Amman. Jordan.

Al-Gazawi, A.A., 1988. Prevalence of some soil fungi and their population trends in two locations cultivated with tomato under different cultural practices in the jordan valley. M.Sc. Thesis, University of Jordan. Amman. Jordan.

Al-Khatib, 2004. Determination and characterization of *Fusarium oxysporum* f. sp. Lycopersici Races in Jordan. Ph.D. Thesis, University of Jordan. Amman, Jordan.

Bowers, J.H. and J.C. Locke, 2000. Effect of botanical extracts on the population density of *Fusarium oxysporum* in soil and control of Fusarium wilt in the greenhouse. Plant Dis., 84: 300-305.

Campbell, R.N., V.H. Schweers and D.H. Hall, 1982. Corky root rot of tomato in California caused by *Pyrenochaeta lycopersici* and control by soil fumigation. Plant Dis., 66: 657-661.

Correll, J.C., 1991. The relationship between formae speicales, races and vegetative compatibility groups in *Fusarium oxysporum*. Phytyopatholog, 81: 1061-1067.

Edelstein, M., 2004. Grafting vegetable-crop plants: Pros and cons. Acta Hort., 659: 235-238.

El-Kallal, S.M., 2007. Induction and modulation of resistance in tomato plant against fusarium wilt diseases by bioagent fungi (*Arbuscular mycorrhiza*) and/or hormonal elicitors (Jasmonic acid and Salicylic acid): 1-Changes in growth, some metabolic activities and endogenous hormones related to defense mechanism. Australian J. Basic Appl. Sci., 1: 691-705.

Elias, K.S. and R.W. Schneider, 1991. Vegetative compatibility groups in *Fusarium oxysporum* f. sp. *lycopersici*. Phytopathology, 81: 159-162.

FAO, 2010. FAOSTAT: Statistical database. Food and Agriculture Organization of the United Nations, Rome, Italy. http://faostat.fao.org/site/339/default.aspx.

Glala, A.A., A.M. Hoda and Z.F. Fawzi, 2005. Improving of tomato growth, health, earliness, productivity and fruit quality by chemically induced systemic resistance. J. Applied Sci. Res., 5: 362-372.

Hawkes, C.V. and J.J. Sullivan, 2001. The impact of herbivory on plants in different resource conditions: A meta-analysis. Ecology, 82: 2045-2058.

Huang, C.C. and P. Lindhout, 1997. Screening for resistance in wild *Lycopersicon* species to *Fusarium oxysporum* f.sp. *lycopersici* race 1 and race 2. Euphytica, 93: 145-193.

Lopez-Berges, M.S., N. Rispail, R.C. Prados-Rosales and A. Di Pietro, 2010. A nitrogen response pathway regulates virulence functions in *Fusarium oxysporum* via the protein kinase TOR and the bZIP protein MeaB. Plant Cell, 22: 2459-2475.

Mamluk, O.F., W.I. Abu Gharbieh, C.G. Shaw, A. Al-Musa and L.S. Al-Banna, 1984. A Checklist of Plant Diseases in Jordan. University of Jordan, Amman, Jordan .

Marlatt, M.L., J.C. Correll, P. Kaufmann and P.E. Cooper, 1996. Two genetically distinct populations of *Fusarium oxysporum* f. sp. *lycopersici* race 3 in the United States. Plant Dis., 80: 1336-1342.

Mes, J.J., E.A. Weststeijn, F. Herlaar, J.J.M. Lambalk, J. Wijbrandi, M.A. Haring and B.J.C. Cornelissen, 1999a. Biological and molecular characterization of *Fusarium oxysporum* f. sp. *lycopersici* divides race 1 isolates into separate virulence groups. Phytopathology, 89: 156-160.

Mes, J.J., R. Wit, C.S. Testerink, F. de Groot, M.A. Haring and B.J.C. Cornelissen, 1999b. Loss of a virulence and reduced pathogenicity of a gamma-irradiated mutant of *Fusarium oxysporum* f. sp. *lycopersici*. Phytopathology, 89: 1131-1137.

Miller, S.A., R.C. Rowe and R.M. Riedel, 2001. Fusarium and Verticillium wilts of tomato, potato, pepper and eggplant. HYG-3122-96. http://ohioline.osu.edu/hyg-fact/3000/3122.html

Nawaz, H., M. Zubair and H. Derawadan, 2012. Interactive effects of nitrogen, phosphorus and zinc on growth and yield of tomato (*Solanum lycopersicum*). Afr. J. Agric. Res., 7: 3792-3799.

Van Ooijen, G., H.A. Van den Burg, B.J. Cornelissen and F.L. Takken, 2007. Structure and function of resistance proteins in solanaceous plants. Ann. Rev. Phytopathol., 45: 43-72.