

ISSN : 1812-5379 (Print)  
ISSN : 1812-5417 (Online)  
<http://ansijournals.com/ja>

# JOURNAL OF AGRONOMY



**ANSI***net*

Asian Network for Scientific Information  
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

## Effect of Potato Cultivars on Incidence of *Fusarium oxysporum* f.sp. *tuberosi* and its Transmission to Progeny Tubers

<sup>1</sup>F. Ayed, <sup>2</sup>M. Daami-Remadi, <sup>1</sup>H. Jabnoun-Khiareddine and <sup>1</sup>M. El Mahjoub

<sup>1</sup>High School of Horticulture and Breeding of Chott-Mariem  
(ESHE-CM), 4042 Sousse, Tunisia

<sup>2</sup>National Institute of Agronomic Research, Tunisia  
(PRRDA-CE Chott-Mariem, 4042 Sousse-Tunisia)

**Abstract:** Behaviour of some potato cultivars to *Fusarium* wilt caused by *Fusarium oxysporum* f.sp. *tuberosi* was studied. Plants were inoculated after two weeks by irrigation with a conidial suspension ( $10^7$  spores mL<sup>-1</sup>). Variations of *Fusarium* wilt incidence were observed on potato 14 cultivars. Cv. Baraka was the most tolerant, Lyra and Platina were the most susceptible and Asterix, Alaska, Safrane and Timate were found to be intermediate with various degrees of response. Pathogen transmission to progeny tubers was assessed by planting daughter tubers coming from inoculated and non inoculated plants. Differences in incidence of cultivar susceptibility were significant. Disease incidence of Latona and Timate was the most and the least important, respectively.

**Key words:** *Solanum tuberosum* L., cultivars, latent transmission, *Fusarium* wilt

### INTRODUCTION

Potato (*Solanum tuberosum* L.) is a crop of significant economic importance in many countries (Rousselle *et al.*, 1996). In Tunisia, over 24.000 ha<sup>-1</sup> of potatoes are grown annually and in 2004 nearly 375.000 tons were produced with a yield of over 15 tons ha<sup>-1</sup> (Anonymous, 2004). Potato production is concentrated on relatively small, diversified irrigated farms, where farmers plant mostly potatoes or other solanaceous crops for several consecutive years in the same field, leading thus to the build-up of soil-borne phytopathogens (Triki *et al.*, 2001). Therefore, the full economic value of this crop has not been achieved because of the impact of several fungal diseases, such as late blight, *Verticillium* and *Fusarium* wilts (Jabnoun-Khiareddine *et al.*, 2005; Ayed *et al.*, 2006).

*Fusarium* wilt of potato, caused by *Fusarium oxysporum* f.sp. *tuberosi*, has become, in the recent years, one of the most serious pathogen of this crop in Tunisia. The pathogen infects plants through the roots via direct penetration or wounds, after which the xylem vascular tissue of the plants is colonized, causing stunting, vascular wilting and death plants (Daami-Remadi and El Mahjoub, 2004; Ayed, 2005). Several strategies for controlling the disease have been introduced, such as soil fumigation, solarization,

long-term rotations and some biological control agents (Daami-Remadi, 2001; Triki *et al.*, 2001; Monnet, 2001). However, serious losses still occur because *F. oxysporum* f. sp. *tuberosi* survives in soil and this persistence has been attributed mainly to the production of long-lived chlamydospores (Kucharek *et al.*, 2000). A promising approach for minimising the severity of the soil-borne pathogen is host resistance. The use of resistant varieties is the most effective and used by farmers (Seilleur, 1996; Vitale *et al.*, 2004).

This study focused on the assessment of the behaviour of fourteen potato tunisian cultivars against *F. oxysporum* f.sp. *tuberosi* in order to select the most tolerant cultivars for their eventual repartition in the truth infested soil. In a second part, incidence of pathogen transmission upon cultivars used will be evaluated on daughter tubers coming from inoculated and uninoculated potato plants.

### MATERIALS AND METHODS

**Plant material:** Fourteen tunisian potato cultivars (Table 1) are supplied by the Technical Potato Centre of Tunisia (CTPT). Tubers of each cultivar, showing optimal germination, were planted in plastic pots (6.74 l) containing an autoclaved mixture of perlite and peat (1:3) and kept at 8-32°C (minimum and maximum

Table 1: Characteristics of fourteen tuber potato cultivars assessed for their tolerance to *F. oxysporum* f.sp. *tuberosi*

Cultivars*	Tuber shape	Skin color	Flesh	% dry matter
Mondial	Oblong and prolonged	Yellow	Yellow	19
Latona	Oblong	Yellow	Yellow	19
Spunta	Oblong and prolonged	Yellow	Yellow	18.5
Alaska	Oblong	Yellow	White	19.2
Pamina	Oblong	Pale yellow	Pale yellow	19.3
Lyra	Oblong and prolonged	Yellow	Clear yellow	18.5
Liseta	Oblong	Yellow	Yellow	19
Fabula	Oval	Pale yellow	Pale yellow	-
Baraka	Oblong	Yellow	Yellow	21
Atlas	Oblong	Yellow	Yellow	19.1
Asterix	Oblong and prolonged	Red	Clear yellow	21.3
Platina	Oblong	Yellow	Yellow	18.5
Safrane	Oblong	Yellow	Yellow	19.2
Timote	Oblong	Yellow	Pale yellow	19

\* These potato cultivars are registered in the list A by Tunisian Technical Potato Centre (CTPT)

temperatures, respectively). Plants were irrigated regularly and fertilized with a nutrient solution (20 N : 20 K<sub>2</sub>O : 20 P<sub>2</sub>O<sub>5</sub>) proposed by Manici and Cerato (1994).

**Fungal isolate:** *Fusarium oxysporum* f.sp. *tuberosi* isolate (FOT), the most aggressive following several pathogenicity tests (Ayed *et al.*, 2006), was obtained from potato tubers showing dry rot symptoms collected from traditional potato-stores. This soil-borne pathogen was cultured on Potato Dextrose Agar (PDA) and incubated at 25°C in the dark. Single spore cultures were maintained in glycerol solution (20%) at -20°C for long-term preservation.

Mycelium taken from the edge of the fungus colony was transferred to 150 mL<sup>-1</sup> of Potato Dextrose Liquid (PDL) and incubated at 25°C for 5 days in a rotary incubator (120 rpm). The liquid culture was filtered and the conidial suspension was adjusted to 10<sup>7</sup> spores mL<sup>-1</sup> by means of a Malassez cytometer.

**Incidence of *Fusarium* wilt on fourteen potato cultivars:** Two weeks after their emergence, plants of each cultivar were inoculated by irrigation with 100 mL of conidial suspension (10<sup>7</sup> spores mL<sup>-1</sup>) and kept at 8-32°C (minimum and maximum temperatures respectively). Non-inoculated control plants were treated similarly with 100 mL of sterile distilled water. Ten plants per elementary treatment were used.

Symptoms severity on foliage was scored several times during growth, up to 30 days after inoculation. A scale of 0-4 was used to assess disease severity weekly: 0 = asymptomatic leaf, 1 = leaf wilted, 2 = Leaf with hemiplegic yellowing, 3 = leaf with necrosis, 4 = dead leaf. Tolerance and susceptibility of each cultivar were expressed as an Index of Leaf Damage (ILD) which is calculated per potato plant (Béye and Lafay, 1985):

$$ILD = \sum \text{notes} / \text{max}$$

ILD : Index of Leaf Damage.

$\sum$  notes : Total notes.

Max : 4 times of developed-leaves number.

#### Transmission of *F. oxysporum* f.sp. *tuberosi* to progeny

**tubers:** Daughter tubers of some cultivars, taken from the previous test and in particularly from inoculated and uninoculated plants, were planted in plastic pots (6.74 L) containing an autoclaved mixture of perlite and peat (1:3) and kept at 2-18°C (minimum and maximum temperatures, respectively). Tubers were apparently healthy. Disease severity assessment is determined as described above. Five plants per elementary treatment were used.

**Statistical analyses:** Data are arranged by a completely randomized factorial design where cultivars and treatments (plants inoculated by *F. oxysporum* f.sp. *tuberosi* and non-inoculated plants) are both fixed factors. They were analyzed using SPSS and subjected to analysis of variance and Fisher's least significant difference test LSD (at p≤5%).

## RESULTS

#### Comparative susceptibility of some potato cultivars to

***Fusarium* wilt:** An assessment of susceptibility of potato cultivars, inoculated by an aggressive *F. oxysporum* f.sp. *tuberosi* isolate (10<sup>7</sup> spores. mL<sup>-1</sup>), was realized after appearance of the first typical *Fusarium* wilt symptom, about 21 days after inoculation. Weekly evolution of Leaf Damage Index (ILD) showed a significant difference between inoculated and non-inoculated plants for all cultivars tested (Table 2).

Differences in the susceptibility of cultivars to *Fusarium* wilt were significant (p≤5%). For 14 cultivars tested, Baraka showed the least leaf damage index with

Table 2: Evaluation of *Fusarium* wilt severity (ILD) on some tunisian potato cultivars from 36 days after planting. NI: Non-inoculated plants, I: Inoculated plants)

Cultivars	Mondial		Latona		Spunta		Alaska		Pamina		Lyra		Liseta		
Days after planting	NI	I	NI	I	NI	I	NI	I	NI	I	NI	I	NI	I	
36	0	0	0	0.014	0	0.038	0	0	0	0.017	0	0.064	0	0.034	
43	0	0.023	0	0.051	0	0.089	0	0	0	0.028	0	0.118	0	0.074	
50	0.026	0.0684	0.099	0.161	0.059	0.132	0.031	0.064	0.039	0.193	0.062	0.171	0	0.12	
57	0.143	0.356	0.399	0.555	0.143	0.377	0.103	0.167	0.149	0.377	0.232	0.381	0.180	0.317	
64	2.041	3.017	2.017	3.75	1.598	2.204	1.361	2.583	1.645	2.587	1.356	2.369	1.387	2.258	
Cultivars	Fabula		Baraka		Atlas		Asterix		Platina		Safrane		Timate		
Days after planting	NI	I	NI	I	NI	I	NI	I	NI	I	NI	I	NI	I	LSD (5%)
36	0	0.011	0	0	0	0.032	0	0.023	0.035	0.068	0	0	0	0	0.023
43	0	0.031	0	0	0	0.052	0	0.028	0.061	0.116	0	0.003	0	0.014	0.028
50	0	0.124	0	0.02	0.025	0.097	0.029	0.045	0.103	0.177	0	0.056	0.018	0.051	0.045
57	0.111	0.306	0	0.038	0.122	0.258	0.119	0.092	0.695	1.493	0.18	0.362	0.125	0.265	0.092
64	1.304	2.352	0.351	0.559	1.833	2.996	1.681	2.612	2.071	2.775	1.986	2.8	1.907	2.87	ns

Table 3: Evaluation of *Fusarium* wilt incidence after planting Non-contaminated (NC) and Contaminated daughter tubers (C)

Cultivars	Mondial		Latona		Liseta		Safrane		Timate		LSD (5%)
Days after planting	NC	C	NC	C	NC	C	NC	C	NC	C	
43	0	0.242	0	0.245	0	0.246	0	0.223	0	0	ns
50	0	0.342	0	0.624	0	0.47	0	0.55	0	0.038	0.280
57	0.113	1.583	0.131	1.75	0.065	2.2	0.186	0.983	0.073	0.615	0.541
64	0.992	2.28	0.849	3	0.525	3.05	0.375	1.95	0.382	1.325	n.s.

Fig. 1: Susceptibility of cv. Baraka (B) to *Fusarium* wilt compared to some cultivars 57 days after plantingFig. 2: Appearance of typical symptoms caused by *F. oxysporum* f.sp. *tuberosi* on non-inoculated plants of Platina 36 days after planting

0.55 at the end of the bioassay (Fig. 1). About 57 days after planting, Asterix and Alaska reached 0.092 and 0.167, respectively; whereas the most important severity disease was noted on Platina where an index of 1.493 was noted.

Typical symptoms of a *Fusarium* wilt disease were observed and noted on non-inoculated plants of some cultivars such as Platina (Fig. 2). These symptoms appeared in the same time for inoculated plants but with a lesser importance.

In the end of the bioassay, an important increase of the leaf damage index was noted on all non-inoculated and inoculated potato plants of each cultivar.

**Transmission of *F. oxysporum* f.sp. *tuberosi* to progeny tubers:** Incidence of daughter tubers contaminated by *F. oxysporum* f. sp *tuberosi* on plant development was studied. A vascular disease symptom was observed 43 days after planting. Results showed an important incidence of *Fusarium* wilt on potato plant development after contaminated daughter tuber planting. For every cultivar, ILD of infected plants was the highest. However, it increased slightly for non infected plants.

Significant difference between cultivars is observed only 50 and 57 days after planting. Timate and Latona had the least and the highest leaf damage index (Table 3), respectively.

At the end of the bioassay, 12 and 52% of plants were dead for non-contaminated and contaminated daughter tubers, respectively.

## DISCUSSION

Variations of *Fusarium* wilt incidence were observed on some potato cultivars. In fact, Baraka was the most tolerant, whereas Lyra and Platina were susceptible. Asterix, Alaska, Safrane and Timate were found to be intermediate with various degrees of response to *F. oxysporum* f.sp. *tuberosi* (Table 1). However, Daami-Remadi and El Mahjoub (1996) signalled that Timate and Baraka were highly susceptible to *F. roseum* var. *sambucinum*. This result difference might account for a distinct degree of resistance to *Fusarium* species and a reaction of cultivars against pathogens (Wastie *et al.*, 1989). Therefore, confidence can be placed in the results of one year's assessment of these cultivars for *Fusarium* wilt resistance, as Wastie *et al.* (1989) found no year  $\times$  cultivar interactions for 15 cultivars tested over 8 years under Scottish conditions. However, Langerfeld (1979) found that variation in the ranking of cultivars infected with *F. coeruleum* could occur between years.

*Fusarium* wilt appearance on non-inoculated plants was attributed to contaminated seed which is considered as a principle source of field infestation (Leach, 1985; Tivoli *et al.*, 1986). Choiseul *et al.* (2001) signalled that when the source of inoculum was the mother tuber, the soil population of *F. sulphureum* at the first sampling date increased linearly until the last sampling time at harvest.

Present results demonstrate that planting daughter tubers coming from inoculated plants can contribute as much to the development of *Fusarium* wilt. Therefore, seed tuber contaminated is considered as an important source of inoculum for the transmission of *F. oxysporum* f.sp. *tuberosi*. Tivoli *et al.* (1988) reported that inoculum level of this pathogen in the plant and in their daughter tubers were similar. Differences in susceptibility between cultivars were signalled about 50 and 57 days after planting. Behaviour of these cultivars could be affected by physiological age of tubers or/and inoculum levels (Tivoli *et al.*, 1986). Moreover, Adams and Lapwood (1983) suggested that differences in sporulating abilities might account for differences in the rate of transmission. They signalled that *F. solani* transmission through the soil from mother to daughter tubers of Pentland Crown was more easily than of Desire or Maris Piper, which are much less susceptible to *F. solani* (Adams and Lapwood, 1983). On other hand, they found M. Piper to be more readily contaminated by *F. culmorum* than the other both cultivars, which are less susceptible.

At the end of the bioassay, abruptly increase of disease severity can be induced by obstruction of the water and nutrient-conducting tissue of inoculated plants as a result of inoculum level increase (Kucharek *et al.*, 2000).

Overall, the study has shown that all cultivars tested revealed different degrees of susceptibility. Baraka was the most tolerant, whereas Lyra and Platina were the most susceptible. Others were found to be intermediate with various degrees of response to *Fusarium* wilt. Moreover, transmission of *F. oxysporum* f.sp. *tuberosi* to daughter tubers was obvious but cultivar reaction to this soilborne wasn't clear. Therefore, further studies are needed to determine the role of tuber physiology in susceptibility to *F. oxysporum* f.sp. *tuberosi* because planting season, fertilization, inoculum level, physiologic age, temperature... etc are factors influencing potato *Fusarium* wilt. Furthermore, studies of wild clones should be also realized for their resistance to *Fusarium* species.

## ACKNOWLEDGMENTS

Authors thank High School of Horticulture and Breeding of Chott-Mariem (ESHE-CM), Technical Potato Centre of Tunisia (CTPT) and Interprofessional Groupment of vegetables (GIL) for their financial contribution. Many thanks for Aymen Youssef for the excellent technical assistance.

## REFERENCES

- Anonymous, 2004. Statistical Directory 2004, Tunisian Agriculture and Hydraulic Resources Ministry.
- Adams, P.B. and M.J. Lapwood, 1983. Transmission of *Fusarium solani* var. *coeruleum* and *F. sulphureum* from seed potato to progeny tubers in the field. Ann. Appl. Biol., 103: 411- 417.
- Ayed, F., 2005. *Fusarium* wilt of potato: Cultivars behaviour and chemical and biological control. Master of Science on Plant and Environment Protection. Horticultural High School of Horticulture and Breeding of Chott-Mariem, Tunisia, pp: 85.
- Ayed, F., M. Daami-Remadi, H. Jabnoun-Khiareddine and M. El Mahjoub, 2006. Potato Vascular *Fusarium* wilt in Tunisia: Incidence and biocontrol by *Trichoderma* spp. Plant Pathol. J., 5: 92-98.
- Béye, I. and J.F. Lafay, 1985. Study of selection criteria for the general resistance in *Verticillium* wilt of tomato. Agronomie, 5: 305-311.
- Choiseul, J.W., L. Allen and S.F. Carnegie, 2001. The role of stem inoculum in the transmission of *Fusarium sulphureum* to potato tubers. Potato Res., 44: 165-172.

- Daami-Remadi, M., 2001. Biological control of *Fusarium* spp. causing potato dry rot. Master of Science on Plant and Environment Protection. High School of Horticulture and Breeding of Chott-Mariem, Tunisia, pp: 72.
- Daami-Remadi, M. and M. El Mahjoub, 1996. Potato *Fusarium* species in Tunisia - II: Behaviour of potato cultivars to some *Fusarium* varieties. *Annales de l'INRAT*, 69: 113-130.
- Daami-Remadi, M. and M. El Mahjoub, 2004. Appearance in Tunisia of *Fusarium oxysporum* f.sp. *tuberosi* causing vascular wilting and tuber dry rot of potato. *Bulletin EOPP/EPPO*, 34: 407-411.
- Jabnoun-Khiareddine, H., M. Daami-Remadi and M. El Mahjoub, 2005. Emergence in Tunisia of new pathotypes of *Verticillium tricorpus* able to attack tomato, egg plant and potato. *Bulletin OEPP/EPPO*, 35: 497-503.
- Kucharek, T., J.P. Jones, D. Hopkins and J. Strandberg, 2000. Some diseases of vegetable and agronomic crops caused by *Fusarium* in Florida. Circular-1025 of Florida Cooperative Extension Service, Institute of Food and Agriculture Sciences and University of Florida.
- Langerfeld, L., 1979. Prüfung des Resistenzverhaltens von kartoffelsorten gegenüber *Fusarium coeruleum* (Lib.) Sacc. *Potato Res.*, 22: 107-122.
- Leach, S.S., 1985. Contamination of soil and transmission of seedborne potato dry rot fungi (*Fusarium* spp.) to progeny tubers. *Am. Potato J.*, 62: 129-136.
- Manici, L.M. and C. Cerato, 1994. Pathogenicity of *Fusarium oxysporum* f.sp. *tuberosi* isolates from tubers and potato plants. *Potato Res.*, 37:129-134.
- Monnet, Y., 2001. Control of soil fungi without fumigation. *Phytoma- La Défense des Végétaux*, 542: 31-34.
- Rousselle, R., Y. Robert and J.C. Crosnier, 1996. Potato: productions, improvement and diseases. Ed. INRA France, pp: 557.
- Seilleur, P., 1996. Genetic improvement of the Resistance to some Pathogens. In: *Traité de Pathologie Végétale*. Les Presses Agronomiques de Gembloux, A.S.B.L. Gembloux, pp: 415-420.
- Tivoli, B., B. Jouan and E. Lemarchand, 1986. Transmission of different *Fusarium* varieties causing tuber dry rot: Seed tubers, soil and plants roles. *Potato Res.*, 29: 141-162.
- Tivoli, B., H. Torres and E.R. French, 1988. Inventory, distribution and aggressivity of species or varieties of *Fusarium* present on potato or in its environment in different agroecological zones in Peru. *Potato Res.*, 31: 681-691.
- Triki, M.A., S. Priou and M. El Mahjoub, 2001. Effects of soil solarization on soil-borne populations of *Pythium aphanidermatum* and *Fusarium solani* and on the potato crop in Tunisia. *Potato Res.*, 44: 271-279.
- Vitale, S., S. Alberino, A. Zoina, B. Parisi and L. Corazza, 2004. Evaluation of resistance to dry and soft rot of potato clones adapted to Mediterranean regions. *Phytopathol. Pol.*, 34: 13-20.
- Wastie, R.L., H.E. Stewart and J. Brown, 1989. Comparative susceptibility of some potato cultivars to dry rot caused by *Fusarium sulphureum* and *F. solani* var. *coeruleum*. *Potato Res.*, 32: 49-55.