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CONTROL OF FUSARIUM DRY ROT DISEASE ON POTATO TUBERS DURING STORAGE CONDITIONS

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ABSTRACT: *Several antagonistic micro-organisms, fungicides and other chemical substances were used for controlling the dry rot disease caused by Fusarium solani on potato tubers during storage conditions. Trichoderma harzianum (1) and T. herzianum2 were the most effective bioagents in controlling the dry rot pathogen under storage in cold conditions. Among the five fungicides tested for controlling the dry rot disease on potato tubers, Rizolex-T and Monceren were the most effective fungicides with (100ppm) under storage in cold conditions. Three organic acids and four Mineral salts were tested as chemical control; Salicylic acid (300ppm) and Calcium phosphate (400ppm) were the most effective in controlling the dry rot disease. Integration among the most effective treatments that used in controlling the Fusarium dry rot under cold storage conditions were reveal that. Salicylic acid (300ppm) + [CaPO4] (400ppm) + Rizolex-T (100pmm) was the most effective treatment in controlling the Fusarium dry rot disease incidence, followed by Salicylic acid (300ppm) +Rizolex-T (100pmm).*

Key words: *Potato, dry rot disease, Fusarium solani, storage diseases, bioagents, fungicides, organic acids, mineral salts and integrated control.*

INTRODUCTION

In Egypt, potato crop is considered one of the most important exportation crops. It is severely attacked by many diseases in the field and during storage; among these; late blight, early blight, dry rot, black scurf, brown rot, black leg, wilt diseases, virus diseases and others. In this regard, Fusarium dry rot is one of the most important post harvest diseases of potato occurring worldwide. This disease cause economic loss and decrease its shelf life. It infected tubers in storage and tuber pieces after planting. Yield losses attributed to dry rot in storage ranging from 6 to 25% with up to 60% of tubers in some infection cases. Also, the dry rot of potato caused by *Fusarium* spp. resulted in significant yield loss in storage and may produce mycotoxins (Abo-El Seoud*, et. al*. 2010). A dry rot of the tubers starts from a wound or bruise and is at first small and brown. Rot on the rotten tuber may be white, rose, or violet. As for the rot progress, a cavity begins to form, the tuber mummifies and ultimately only the dry shell persists. Lesions from *F. solani var. coeruleum* infection start at the side of the infection and progress in a fairly uniform manner through the tuber (Ocamb 2008). The sprayed tubers with conidiospore suspension of *Trichoderma viride* in potato dextrose broth showed a drastic reduction in the range and number of mycoflora such as *F. solani* on the tuber surface during months of storage (Okigbo and Ikediugwu 2001). Fusarium dry rot disease incidence was significantly lower in potato boxes treated with each antagonist alone as compared with pathogen inoculated control boxes and to those treated with the fungicide (Sadfi *et al*. 2002).The losses caused by Fusarium tuber dry rot can be minimized by the application of fungicides; *i.e.* Monceren (pencycuron), Selest 10% (Fludioxonil), Rizolex-T (tolclofos-methyl); Tecto (thiabendazole) and Vitavax 300 (carboxin + thiram) and as well as organic acid and the mineral salts; *i.e.* Sodium benzoate, Salicylic acid, Citric acid, Oxalic acid, Sodium carbonate, Calcium phosphate and Calcium chloride after harvesting or pre-planting (Graham, *et al*. 1982, Saad and Stino 1982 and Hide, *et al.* 1992).

This study aimed to control the Fusarium dry rot disease on potato tubers during storage conditions using bioagents, fungicides, organic acids, mineral salts and the integration between them.

MATERIALS AND METHODS:

1. Occurrence and isolation of the causal organism.

Naturally infected potato tubers showed typical symptoms of dry rot disease; forming rot on tubers; crumbly decay and the fungus was found to grow in the rotten tuber; the fungus may be reddish, white, yellow or dirty tan in color (fig 1).

Occurrence of dry rot disease on potato tubers was focused during six years from 2004 to 2010 in naturally infected planting areas at, Ismailiya (El-Shabab, El-Salhiya & Wadyi Elmollak), Behaira (El-Nobaria, El-Tahrier, Kom-Hamada & Wadi Elnotron), Minufiya (Ashmon, Sadat, Menouf & Elshohada) , Dakahliya (Talkha), El-Gharbiya (Kafer El-Zaiat & El-Mehala), Qaliubiya (Qaliub& El-Kanater), El-Minia (El-Minia), Giza (Desert road) eighteen districts belonging to eight governorates. Tuber samples were collected from fields of potato (cv. Spunta the highest susceptible cultivar) in each location and examined. The isolated fungi were examined microscopically and identified according to Parameter *et al.* (1969). These fungi were purified using the hyphal tip and/or single spore technique according to (Barnett 1960 and Domsch *et al.* 1980). Then, they were examined microscopically their identification was confirmed, based on cultural and microscopical characters according to Barnett (1960) and Booth (1971). Specie of *Fusarium* was identified according to (Nelson, *et. al.* 1983). Ten inoculated potato tubers in each replicate were stored in sterilized packing under cold condition (13°C -15°C) and RH=90% and sterilized tubers only as a control. Inoculation technique consists of deposing an agar disc (6mm diameter) colonized by pathogen at wound (6 mm diameter and depth) occasioned on tubers by cork borer and covered by a layer of wax. After the incubation period, tubers were cut longitudinally via sites of inoculations and the rotted tissues were weighted. Parameters of dry rot depth, dry matter of inoculated tubers and maximum width (W) and depth (D) were recorded. The pathogen penetration into tuber is calculated using a formula developed for this purpose as follows (Lapwood, *et. al*.1984).

Penetration (mm) = [(w/2) + (d-6)]/2

Where: w= maximum width --- d= depth

Fig (1): Symptoms of *Fusarium* dry rot on potato tubers (cv. Spunta) showing the internal rotting tissues

2. Effect of antagonistic microorganisms:

The dilution plate method was used for isolation of soil micro-organisms. Desired dilution (0.1 ml) of liquid was spread in Petri plates containing 15 ml of soil modified specific media for each group of microorganisms. Selective media (Martin medium) for fungi (Elad *et al.* 1981).

The composition of used various media isolation is given below. The selected cultures were identified at the laboratory of plant pathology, Agricultural Botany Department, Faculty of Agriculture, Minufiya University. The obtained *Trichoderma* spp. were identified according to the key developed by Rifai (1969) and Bissett (1991).

These antagonistic micro-organisms were *Trichoderma viride* (TV), *T. hamatum* (TM), *T. reseei* (T.R), *T. harzianum-1* (TZ1),*T. harzianum-2*(TZ2) , *T. harzianum*-3 (TZ3), *T. aureoviride*(TA), *T. koningii*-3 (TS_3),, *Gliocladium virnes* (GV), and *T. polysporum*-2 (TS_2). Surface sterilized potato tuber cv. Spunta were injured using sterile blade then the tubers were soaked in antagonistic micro-organisms solution for 48 hours (Rowe *et al*. 1995). Ten inoculated potato tubers in each replicate were stored in sterilized packing (carton box 25×25cm) under cold condition (13°C -15°C) and RH=90%, ten sterilized potato tubers were stored in sterilized packing as control.

After incubation period, tubers were cut longitudinally via sites of inoculations and the rotted tissues were weighted. Parameters of dry rot depths of were recorded. The obtained data were statistically analyzed according to Fisher's L.S.D at 1-5 % (1935).

3. Effect of fungicides:

Five fungicides were tested as chemical control against *F. solani* (the causal pathogen of dry rot disease of potato). The tested fungicides were Monceren (pencycuron), Selest 10% (Fludioxonil), Rizolex-T (tolclofos-methyl), Tecto (thiabendazole) and Vitavax 300 (carboxin + thiram) at the concentration 100 ppm.

Potato tubers were stored in two years and two successive seasons of summer and nili plantation. Surface sterilized potato tubers cv. Spunta were injured using sterile blade then tubers were soaked in fungicidal solutions for 30 minutes.

Ten inoculated potato tubers in each replicate were stored in sterilized packing(carton box 25×25cm) under cold condition (13°C -15°C) and RH=90%. Also, ten sterilized potato tubers were stored in sterilized packing as control.

Effects of five fungicides at storage on dry rot disease incidence were assessed as percentages of the disease incidence 30 days post storage. After incubation period, tubers were cut longitudinally via sites of inoculations and the rotted tissues were weighted.

Parameters of dry rot depth were recorded and the obtained data were statistically analyzed according to Fisher's L.S.D at 1-5 % (1935).

4. Effect of organic acids and some mineral salts:

Several organic acids and mineral salts were tested for their effect against *F. solani* (the causal pathogen of potato dry rot disease). The tested organic acids were Salicylic acid, Citric acid and Oxalic acid and while, the mineral salts were Sodium benzoate, Sodium carbonate, Calcium phosphate and Calcium chloride.

The tested organic acids and Sodium benzoate at the concentration 300ppm and Mineral salts at the concentration 400ppm. In the two seasons, the storage potato tubers cv. Spunta were prepared for applying organic acids and mineral salts as mentioned before. Five replicates were used for each treatment. Ten inoculated potato tubers in each replicate were stored in sterilized packing (carton box 25 ×25cm) under cold condition(13°C-15°C) and RH = 90%,ten sterilized potato tubers were stored in sterilized packing as control.

Effects of the seven organic acids and mineral salts treatments on the disease incidence were scored as percentages of the disease incidence 30 days post storage.

After incubation period, tubers were cut longitudinally via sites of inoculations and the rotted tissues were weighted. Parameters of inducted dry rot depth of rotting are scored. The obtained data were recorded and statistically analyzed Fisher's L.S.D at 1-5 % (1935).

5. Integrated control of Fusarium dry rot disease:

In this respect, the integration among the most effective treatments of tested bioagents, fungicides, organic acids and mineral salts was for controlling potato dry rot disease during storage.

The trial consisted of twelve treatments namely (1) *T. harzianum-1* (TZ1), (2) Salicylic acid at 300ppm, (3) Calcium phosphate [CaPO4] at 400ppm, (4) Rizolex-T at 100pmm, (5) [TZ1] + Salicylic acid at 300ppm, (6) [TZ1] + Calcium phosphate at 400ppm, (7) Salicylic acid at 300ppm + [CaPO4] at 400ppm, (8)Salicylic acid at 300ppm + Rizolex-T at 100pmm, (9)[CaPO4] at 400ppm + Rizolex-T at 100pmm, (10) Salicylic acid at 300ppm +[CaPO4] at 400ppm + Rizolex-T at 100pmm , (11) control + pathogen and (12) control.

After incubation period, tubers were cut longitudinally via sites of inoculations and the rotted tissues were weighted. Surface sterilized tubers were injured by sterile blade then the tubers were soaked into the mixed solutions of tested material for 30 minutes. Effects of twelve treatments (as integrated control) on the disease incidence were assessed as percentages of the disease incidence, 30 days post storage.

After incubation period, tubers were cut longitudinally via sites of inoculations and the rotted tissues were weighted. Parameters of dry rot depth were recorded then the obtained data were statistically analyzed Fisher's L.S.D at 1-5 % (1935).

RESULTS AND DISCUSSION

Fusarium solani was the main causal organism of dry rot disease of potato tubers in the Egyptian potato growing fields.

The sandy soil in both Ismailiya and Behaira might be encourage *Fusarium* infection and disease incidence in potato tubers than clay loam soil especial in nili season at Delta (El-Minia, Qaliubiya, Minufiya, Giza, Dakahliya and El-Gharbiya governorates) Ocamb (2008) and Li, *et al.* (2010).

Disease incidence was high in Ismailiya governorate in both tested seasons 2005 and 2006 followed by the collected samples from Behaira governorate in both seasons as clear in Table (1).

Table (1): Percentage of dry rot disease incidence on cv. Spunta in eight governorates during two successive seasons 2005 and2006

Governorate	Disease incidence% of Fusarium dry rot on potato tubers				
	٢٠٠٤/٢٠٠٥		2005/2006		Mean of tow seasons
	Nili	summer	Nili	summer	
Ismailiya	12.5	١٢.٥	12.5	12.7	12.5
Behaira	11.0	١١.٢	11.1	11.4	11.2
Minufiya	5.6	٥.٨	5.6	5.7	5.7
Dakahliya	4.0	٣.٢	3.8	3.6	3.7
El-Gharbiya	3.3	٢.٩	3.1	3.27	3.1
Qaliubiya	2.7	2.6	2.6	2.7	2.7
Elminia	2.3	2.2	2.2	2.3	2.3
Giza	4.4	4.8	4.4	4.8	4.6
L.S.D 0.01	1.278	1.105	1.216	1.010	
L.S.D 0.05	0.955	0.825	0.908	0.904	

Data in Table (2) show that the highest average of disease incidence was 24.74 % in both tested seasons, where, the recorded dry rot disease incidence were 24.83 and 24.68% in 2005 while they were 24.77, 24.68% in 2006 seasons, for both nili and summer plantations seasons, respectively.

In the case of *F.solani* isolate (CD5) that isolated from El-Tahrier district, Behaira governorate; followed by (A11) that isolated from El-Salhiya district, Ismailiya governorate (24.04%).

With regard to biological control under cold storage conditions data in Table (3) reveal that, all tested bioagents significantly reduced the dry rot disease incidence, where *Trichoderma harzianum-1* (TZ1) was the most effective bioagent in controlling the dry rot disease, followed by *T. herzianum-2* (TZ2) and *T. polysporum*(TS2) mean while, the rest bioagents varied in their effect on reducing the disease incidence.

T. harzianum-1 (Tz1) reduced the incidence of dry rot with 76.64% comparing with the infested tubers without bioagent treating, followed by *T. harzianum-2* (TZ2) and *T. polysporum 2* (TS2) which recorded 70.27 and 64.38 % reduction of dry rot %, respectively. These results are agreement with those obtained Panwar, *et al*. (2004) and Al- Mughrabi (2010)

Table (2): Pathogenicity test of of *Fusarium solani* on stored potato cv. Spunta under cold conditions (13c°- 15c°) for 30 days in two seasons.

Governorates	Codes	Districts	Disease incidence% of Fusarium dry rot on potato tubers cv. Spunta				
			2005		2006		Mean of two seasons
			Nili	summer	Nili	summer	
Ismailia	A1	El-shabab	23.14	23.17	22.95	23.08	23.09
	A11	El-salhiya	24.19	23.83	24.23	23.93	24.04
	A21	Wadi Elmollak	19.62	19.58	19.65	19.55	19.60
Beheira	CD12	El-Nobariya	23.78	23.43	23.85	23.42	23.62
	CD5	Eltahrier	24.83	24.68	24.77	24.68	24.74
	CD4	Komhamada	15.92	15.80	15.83	15.71	15.82
	I	Wadi Elnotron	21.42	21.22	21.36	21.11	21.28
Minufiya	B1	Ashmon	14.74	14.36	14.85	14.34	14.57
	B5	Sadat	19.05	17.79	19.11	18.52	18.62
	P4	Menouf	14.26	14.04	14.16	14.03	14.12
	P14	Elshohada	13.69	13.49	13.55	13.31	13.51
Dakahliya	D	Talkha	13.02	12.84	13.08	12.90	12.96
El-Gharbiya	N1	Kafer elzaiat	12.69	12.54	12.75	12.52	12.62
	N2	Elmehalla	12.59	12.47	12.61	12.46	12.53
Qaliubiya	S14	Elqanater	12.77	12.64	12.72	12.61	12.69
	S4	Qaliub	12.69	12.54	12.68	12.56	12.62
Elminia	M	Elminia	11.26	11.10	11.27	11.04	11.17
Giza	F	Desert road	23.14	23.17	22.95	23.08	23.09
L.S.D 0.01			0.43	0.46	0.35	0.34	
L.S.D 0.05			0.32	0.35	0.26	0.26	

Table (3): Effect of bioagants on Fusarium (CD5) dry rot disease incidence on cv. Spunta under cold conditions (13c°-15c°) in two successive seasons 2008/2009.

Test bivalents	Disease incidence% of Fusarium dry rot on potato tubers cv. Spunta					
	2008		2009		Mean	Reduction %
	Nili	summer	Nili	summer		
T. viride	10.88	10.9	10.80	10.54	10.78	56.81
T. hamatum	15.97	15.96	15.79	16.04	15.94	36.14
T. reseei	13.44	13.44	13.42	13.26	13.39	46.35
T. harzianum (1)	5.90	5.90	5.72	5.79	5.83	76.64
T. koningii (3)	15.5	15.47	15.56	15.44	15.49	37.94
T. aureoviride	15.39	15.35	15.41	15.34	15.37	38.42
Glioclodium virnes	16.29	16.23	16.43	16.28	16.31	34.66
T. polysporum (2)	8.95	8.92	8.81	8.88	8.89	64.38
T. harzianum (2)	7.37	7.40	7.43	7.48	7.42	70.27
T. harzianum(3)	11.31	11.33	11.45	11.34	11.36	54.48
C|ontrol +path	24.90	24.96	24.93	25.04	24.96	00
Control un infected	00	00	00	00	00	00
L.S.D 0.01	0.411	0.361	0.238	0.262		
L.S.D 0.05	0.309	0.271	0.178	0.197		

The most effective concentration of each fungicide was selected for storage experiment. The tested fungicides Vitavax 300, Selest, Rizolex, Tecto and Monceren at the concentration 100 ppm, were studied under cold storage conditions. Rizolex fungicide was the most effective one in controlling the dry rot disease incidence, followed by Monceren and Vitavax. Dry rot disease incidence were 5.18, 7.40 and 7.75%, while the reduction of the disease was 79.15, 70.22 and 68.81%, respectively (Table 4) .

Tecto was the lowest effective fungicides in controlling the dry rot disease incidence, followed by Selest. The percentages of infection were 16.91 and 9.32%, while the reduction of the disease was 31.95 and 62.49%, respectively.

Similar results were noticed by Ocamb, *et al.* (2007); Remadi, *et al.* (2006) and. Wharton *et al.* (2007).

Three organic acids and four Mineral salts were tested to control *F. solani* the causal pathogen of dry rot disease of potato. Among the tested organic acids, Salsellk acid with at 300 ppm was the most effective in controlling the dry rot disease incidence, followed by Sodium benzoate at 300 ppm. The percentages of infection were 10.54 and 13.55%, while the reduction of the disease was 57.74 and 45.67%, respectively (Table 5).

Among the tested mineral salts Calcium phosphate was the most effective with (400 ppm) followed by Sodium carbonate with (400 ppm) .The percentages of infection were 11.63 and 13.19%, while the reduction of the disease were 53.37 and 47.11 %, respectively. These results are in accordance with those obtained by Tweddell, *et al*. (2003) and Yin, *et al*. (2010).

Table (4): Effect of some fungcidies at Concentration100 ppm on dry rot disease of potato cv. Spunta under cold conditions (13c°-15c°) in two successive seasons 2009/2010

Test Fungicides	Fusarium dry rot incidence %					
	2009		2010		Mean of tow seasons	Reduction %
	nili	summer	nili	summer		
Vitavax 50	7.38	7.90	7.64	8.07	7.75	68.81
Selest 10%	8.98	9.45	9.07	9.79	9.32	62.49
Rizolex 10%	5.02	5.36	4.95	5.40	5.18	79.15
Tecto	16.55	16.98	16.67	17.43	16.91	31.95
Monceren	7.31	7.28	7.24	7.75	7.40	70.22
control+ path0gen	24.6	25.06	24.64	25.11	24.85	00
control	00.00	0.00	0.00	0.00	0.00	0.00
L.S.D 0.01	0.28	0.45	0.26	0.25		
L.S.D 0.05	0.21	0.34	0.19	0.19		

Table (5): The effect of some organic acids and some mineral salts on Fusarium dry rot disease on Spunta variety under cold conditions (13c°-5c°) in the two successive seasons 2009/2010

Treatments	Concentration (ppm)	Fusarium dry rot incidence %					
		2009		2010		Mean of tow seasons	Reduction %
		nili	summer	nili	summer		
Salicylic acid	300	10.36	10.54	10.53	10.71	10.54	57.74
Citric acid	300	14.30	14.38	14.28	14.43	14.35	42.50
Oxalic acid	300	15.46	15.85	15.47	15.46	15.56	37.61
Sodium benzoate	300	13.47	13.64	13.33	13.74	13.55	45.67
Sodium carbonate	400	13.03	13.21	13.19	13.31	13.19	47.11
Calcium phosphate	400	11.63	11.85	11.43	11.61	11.63	53.37
Calcium chloride	400	13.69	13.76	13.66	13.92	13.76	44.83
Control +Pathogen		24.77	25.10	24.81	25.08	24.94	00.00
Control		0.00	0.00	0.00	0.00	0.0	00.00
L.S.D 0.01		0.51	0.51	0.41	0.52		
L.S.D 0.05		0.38	0.38	0.31	0.39		

The most effective treatments that used to integrated control of Fusarium dry rot under cold storage conditions were used in this test (Table 5). Salicylic acid 300ppm + [CaPo4] 400ppm + Rizolex 10% 100pmm was the most effective treatment in controlling the Fusarium dry rot disease incidence, followed by Salicylic acid 300ppm +Rizolex 10% 100pmm, The percentages of infection were3.74 and 4.24%, while the reduction of the disease were 85.00 and 82.96%, respectively (Table 6). Calcium phosphate 400 ppm was the lowest effective treatments in controlling the dry rot disease incidence, followed by Salicylic acid 300ppm, Salicylic acid 300ppm +(CaPo4) 400ppm and (TZ1)+ Salicylic acid 300ppm (These results are confirmed obtained by Tyuterev and Tkachenko 2000, Olsen *et al*. (2003) , Dezdani *et al.* 2003 and YIN *et al*. 2010).

Table (١): Effect of integrated control of Fusarium dry rot disease on cv.Spunta under cold conditions (13c°-15c°) in two seasons 2009-2010

Treatments	Fusarium dry rot incidence %					
	2009		2010		Mean of tow seasons	Reduction %
	nili	summer	nili	summer		
T. harzianum1 (TZ1)	5.98	5.94	5.97	5.90	5.95	76.10
Salicylic acid 300ppm	10.66	10.49	10.45	10.48	10.52	57.75
Calcium phosphate($CaPO_4$) 400ppm	11.54	11.58	11.70	11.57	11.60	53.41
Rizolex 10% 100pmm	5.24	5.32	5.31	5.33	5.30	78.71
(TZ1)+ Salicylic acid 300ppm	7.36	7.38	7.07	7.18	7.25	70.88
(TZ1)+ Calcium phosphate 400ppm	6.85	6.84	6.96	6.02	6.67	73.22
Salicylic acid 300ppm +($CaPO_4$) 400ppm	8.11	7.98	7.88	7.92	7.97	67.99
Salicylic acid 300ppm +Rizolex 10%100pmm	4.23	4.29	4.22	4.23	4.24	82.96
(CaPo4) 400ppm + Rizolex 10%100pmm	5.19	5.22	5.11	5.18	5.18	79.20
Salicylic acid300ppm +($CaPO_4$) 400ppm + Rizolex 10% 100pmm	3.88	3.72	3.63	3.71	3.74	85.00
control +path	24.95	24.86	24.89	24.89	24.90	0.00
control	0.00	0.00	0.00	0.00	0.00	0.00
L.S.D 0.01	0.32	0.34	0.36	0.28		
L.S.D 0.05	0.24	0.25	0.27	0.21		

REFERENCES

Abo- El Seoud, M.A., M.M. Sarhan, A.M. Galal and M.M. Helal (2010). Effect of gamma radiation and formulated essential oils on stored potato tubers. Proceeding, 2nd International Conference on Radiation Sciences and Applications on 28 March -1 April 2010.

Al-Mughrabi, K.I. (2010). Biological control of Fusarium dry rot and other potato tuber diseases using *Pseudomonas fluorescens* and *Enterobacter cloacae* . Biological Control, 53(3): 280-284.

Barnett, H.L. (1960). Illustrated genera of imperfect fungi. West Virg. UNIV., phytopathology p. 225 231–240, October 1967.

Bisset, J. (1991). A revision of the genus *Trichoderma*. II. Infrageneric classification. Can. J. Bot. 69:2357–2372.

Booth, C. (1971). The Genus Fusarium, Commonwealth Mycology Institute, Kew, Surrey, England p.237.

Dezdani, G.H., M.F. Rastegar, B. Jafarpour and M.M. Eskandari (2003). Determination of Vegetative Compatibility Groups (VCGs) of *Fusarium oxysporum* f.sp. *tuberosi* in Khorasan Province. Iranian Journal of Agricultural Sciences,34(1): 67-75.

Domsch, K.H., W. Gams and T.H. Anderson (1980). Compendium of Soil Fungi. Vol.1, London, Academic Press,859 pp.

Elad, Y., I. Chet and Y. Heni (1981). A selective medium for improving quantitative isolation of *Trichoderma* spp.from soil.

Fisher, R.A. (1935). The design of experiments. Edinburgh: Oliver and Boyd.

Graham, D.C., G.A. Hamilton, C.E. Quinn and A. D. Ruthven (1981). Summary of results of experiments on the control of the potato tuber fungal diseases gangrene, dry rot and skin spot With various chemical substances.Potato Research ; 24(2): 147-158.

Hide, G.A., P.J. Read and S.M. Hall (1992). Resistance to thiabendazole in Fusarium species isolated from potato tubers affected by dry rot. Plant Pathology, 41(6) 745-748.

Lapwood, D.H., P.J. Read and J. Spokes (1984). Methods for assessing the susceptibility of potato tubers of different cultivars to rotting by *Erwinia carotovora* subsp. *atroseptica* and *carotovora*. Plant Pathology, 33: 13-20.

Li, Y.C., X.J. Sun, Y. Bi and Y. Wang (2010). Postharvest sodium silicate treatment induces resistance in potato against *Fusarium sulphureum* (ISHS)877:1675-1681.

Nelson, S. E., J. A. Toussoun and W. F. Marasas (1983). *Fusarium* spp. and illustrated manual for identification. The Pennsylvania State Univ. Press, USA p.150.

Ocamb, C.M. (2008). Potato (*Solanum tuberosum*) Fusarium Dry Rot. American Journal of Potato Research, (1): 642 .

Ocamb, C.M., P.B. Hamm and D.A. Johnson (2007). Benzimidazole resistance of Fusarium species recovered from potatoes with dry rot from storages located in the Columbia Basin of Oregon and Washington. American Journal of Potato Research; 84(2): 169-177

Okigbo, R.N. and F.E.O. Ikediugwu (2001). Biological control of tuber surface mycoflora of yams(*Dioscorea rotundata*). Tropical Science. 41(2): 85-89.

Olsen, N.L., G.E. Kleinkopf and L.K. Woodell (2003). Efficacy of chlorine dioxide for disease control on stored potatoes American-Journal of Potato Research. 80(6): 387-395 .

Panwar, S., V. Sunaina, D.K. Tomar, A. Sharma and L. Singh (2004). Evaluation of Enterobacter sp. KH-7 for biocontrol of Fusarium dry rot of potato. Plant Archives; 4(1): 49-51

Parameter, J.R., R.T. Sherwood and W.D. Platt (1969). Anastomosis grouping among isolates of thanatephorus cucumeris. Phytopathology, 59 (1) 1277-1278

Remadi, D.M., F. Ayed, J.H. Khiareddine, K. Hibar and M. El- Mahjoub (2006). In vitro, in vivo and in situ evaluation of fungicides tested individually or in combination for the control of the Fusarium dry rot of potato. International Journal of Agricultural Research.1(6): 564-572.

Rifai, M. A. (1969). A revision of the genus *Trichoderma*.Mycol. Pap.116:1–56.

Rowe, R.C., S.A. Miller and R.M. Riedel (1995). *Fusarium* Dry Rot and Seed-Piece Decay of Potato. The Ohio State University Extension Fact Sheet Plant Pathology, 35(10): 77.

Saad, N.H. and M.N. Stino (1982). Susceptibility of some potato varieties to storage rots in Egypt and its chemical control. Agricultural Research Review, 60(2):, 183-194

Sadfi, N., M. Cherif, M.R. Hajlaoui and A. Boudabbous (2002). Biological control of the potato tubers dry rot caused by *Fusarium roseum* var. *sambucinum* under greenhouse, field and storage conditions using *Bacillus* spp. isolates. Journal of Phytopathology , 150(11-12): 640-648.

Tweddell, R.J., R. Boulanger and J. Arul (2003). Effect of chlorine atmospheres on sprouting and development of dry rot, soft rot and silver scurf on potato tubers. Postharvest Biology and Technology; 28(3): 445-454

Tyuterev, S.L. and M.P. Tkachenko (2000) . Rational use of modern fungicides on

potato. Zashchita I Karantin Rastenii, 9: 28-30.

Wharton, P.S., W.W. Kirk, D. Berry and P. Tumbalam (2007). Seed treatment application-timing options for control of *Fusarium* decay and sprout rot of cut seedpieces. American Journal of Potato Research; 84 (3):237-244

Yin, Y., Y.C. Li, B.I. Yang, S.J. Chen, L. Yuan, L. Wang and D. Wang (2010). Postharvest Treatment with β-Aminobutyric Acid Induces Resistance Against Dry Rot Caused by *Fusarium sulphureum* in Potato Tuber. Agricultural Sciences in China, 9 (9): 1372-1380.

مقاومة مرض العفن الجاف الفيوزارمي في درنات البطاطس أثناء التخزين

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الملخص العربي

يعتبر مرض العفن الجاف الفيوزارمي من أهم الأمراض التي تصيب درنات البطاطس حيث يسبب خسائر اقتصادية كبيرة في جميع مناطق زراعات البطاطس في مصر والعالم سواء في الحقول أو أثناء التخزين. ولمقاومة مرض العفن الجاف الفيوزارمي تم استخدام عزلات من كائنات التضاد الحيوي لمقاومة المرض وقد ثبتت فعالية جميع العزلات المختبرة في خفض درجة الإصابة بالمرض تحت ظروف التخزين البارد علي حرارة ١٣–١٥درجة مئوية ورطوبة نسبية٩٠ % وكان أكثرها تأثيراً العزلة ترايكودرما هارزيانم ١ .تم استخدام خمسة مبيدات فطرية فكان أكثرها فعالية في المقاومة المبيد ريزولكس تي يليه المبيد مونسرين بتركيز ١٠٠ جزء في المليون تحت ظروف التخزين البارد . وقد تم اختبار تأثير ثلاثة أحماض عضوية واربعة أملاح معدنية تحت ظروف المخزن فكان حمض الساليسيلك بتركيز ٣٠٠ جزء في المليون أكثرها فاعلية في مقاومة المرض يليه بنزوات الصوديوم وفوسفات الكالسيوم بتركيز ٤٠٠ جزء في المليون . وفي المقاومة المتكاملة تم استخدام أفضل المعاملات من النتائج السابقة بخلطها معاً واستخدامها في مقاومة المرض في المخزن علي الدرنات حيث وجد أن الخليط من المبيد ريزولكس بتركيز ١٠٠ جزء في المليون + حمض الساليسيلك بتركيز ٣٠٠ جزء في المليون + فوسفات الكالسيوم بتركيز ٤٠٠ جزء في المليون كانت أفضل المعاملات يليها المبيد ريزولكس بتركيز ١٠٠ جزء في المليون + حمض الساليسيلك بتركيز ٣٠٠ جزء في المليون .