J. Plant Prot. and Path., Mansoura Univ., Vol.9 (8): 489 – 496, 2018

Potential of Streptrol and Oxolinic Acid Bactericides to Controlling Potato Erwinia Soft Rot Bacteria and their Secondry Effects on Growth, Yield and Tubers Quality

Roshdy, A. H.[1]; Sanaa A. Masoud[2] and S. Abdel R. Hamed[3]

[1] Horticulture Dept., Agric. Fac., Damanhour Univ.

[2] Central Pesticide Laboratory, Agriculture Research Center, ItaiElbaroud

[3] Plant protection Departtment, Faaculty of Agricculture,Tanta university, Egypt.

ABSTRACT

Two successive experiments were conducted. The first was laboratory experiment to examine the best bactericidal effect of streptrol and oxolinic acid according to the inhibition zone on different 10 isolates of*Erwiniacarotovora* subsp. *carotovora*. The results showed that the concentration of 100 ppm of each streptrol or oxolinic acid gave the highest inhibition zone with significant superiority of streptrol over oxolinic acidwith percentage estimated by 30.49%. The erwinia isolates E_2 and E_5 were found to be the most sensitive; while, the isolates of E_7 and E_9 were the most resistance regardless the used bactericides according to their inhibition zones. The second experiment was conducted in the greenhouse to study the effect of streptrol and oxolinic acidwith 100 ppm on potato plant infected with each of E_2, E_5, E_7 and E_9erwinia isolates, in addition to uninfected potato to study the secondary effects of the applied bactericides on the growth, yield and tubers quality of the treated potato plants. The greenhouse experiment revealed that the erwinia isolates of E_7 and E_9 caused more significant reduction of the studied parameters compared with the isolates of E_2 and E_5, in 2015-2016 seasons. Also, the using of streptrol in concentration of 100 ppm gave the most bactericidal effect regardless the used erwinia isolate. In addition, the results showed that each of streptrol or oxolinic acid did not show any significant secondary effects on all studied characters except shoot fresh weight, in both seasons of study.

Keywords: Erwinia, potato, streptrol, oxolinic acid, secondry effects.

INTRODUCTION

In Egypt, potato is the most important vegetable crop which devoted to local consumption andexportation,it is about 20% of total area devoted for vegetable production is cultivated with potato (Kabeil*et al*., 2008). The Egyptian total production of potato strongly increased with 45.92%, which was 2.31 million tons in 2006 and5.03 million tons in 2016 (FAOSTAT).

Unfortunately,Potatoes are facing about 40 soil-borne diseases, which causing significant loss in quantity and quality of potato tubers (Fiers*et al*., 2012).One of the most important of these diseases is the bacterial soft rot which caused by*Eriwiniacarotovora*subsp. *carotovora* bacteria, which has the ability to infect wide range of plants. Also, *Erwinia*genus produce many of extracellular depolymerasis such aspectatelyases, polygalacturonases, proteases and cellulases, which help the host plant penetration consequently causing severe damage in the infected plants (Ageichik*et al*., 2002 and Abd El-Khairand Karima, 2007).

There are few bactericides devoted for controlling plant bacterial diseases which are mostly considered as antibiotics such as streptrol, which is also called agricultural streptomycin, formulated as streptomycin sulfate in a 17% wettable powder form (Horst, 2013) and oxolinic acid, which considered as synthetic antibiotic relatedto quinoline family that have a bactericidal influence against gram negative bacteria (Shtienberg, *et al*., 2001).

There are many researchers focused their investigations on the secondary effects of different types of pesticides on the different physiological aspects of treated plants (García *et al*., 2003;Karthikeyan *et al*., 2003 and Gaikwad *et al*., 2017). These studies differ in the used of pesticides and the treated crops, as well as the measurements taken for the purpose of indicating the various physiological effects a result of treatment with pesticides. Such studies revealed that the pesticides application could be affect the germination process (Parashar and Sindhan 1988 on potato;Moore and Kroger, 2010 on rice and Rajashekharand Murthy, 2012 on maiz), vegetative growth characters (Youngman *et al*., 1990 on cotton; Hongtao*et al*., 2003; Tiyagi*et al*., 2004 on chickpea; Mishra *et al*., 2008 on cowpea, Basantani*et al*., 2011 on *Vignaradiata* and Mendez and Manuel, 2014 on *Oryza sativa*) and yield and its components (Amengor and Tetteh, 2008 , Goré*et al*., 2011 on watermelon and Gaikwad*et al*., 2017).

Also, the researchers found that the application of different types of pesticideswas affected the photosynthetic system and pigments content (Toscano*et al*., 1982 on lettuce; Yahong*et al*., 1991 on potato; Krugh and Miles, 1996 on mung bean; Haile *et al*., 1999 on alfalfa and soybean and Yoon *et al*., 2011 on squash and Mendez and Manuel, 2014 on V*ignasinensis* and *Oryza sativa*) enzymatic system of the treated plants (Sergiev*et al*., 2006 on maize and Bashir *et al*., 2007 on *Glycine max*;), sugars contents (El-Bessomy, 1993 and Woda, 1994 on potato) the nodules formation and nitrogen fixation process (Ilieva and Vasileva, 2014 on soybean) in addition, there were some kinds of pesticides exploited even in tissue culturesystems (Shields*et al*., 1984 and Debergh*et al*., 1993).

The above mentioned investigations demonstrated, generally that these effects could be in positive, negative direction or has no secondary effect depending on the examined plant crop, the kind of the applied pesticide in addition to its used concentration.

The objectives of this research are to study the inhibitory effect of each of streptrol and oxolinic acid bactericides on the growth of *Erwiniacarotovora* subsp. *carotovora* isolates under laboratory conditions and to study the efficacy of these bactericides in controlling of caused soft rot disease, and to study whether these pesticides have secondary effects on growth, yield and the contents of sugars and starch of potato plant tubers under greenhouse conditions.

MATERIALS AND METHODS

Two consecutive experiments were conducted. The first one was a laboratory experiment, and the second one was conducted as two successive pot experiments in the seasons of 2015 and 2016.

Tested bacteria: In the current study Ten isolates of *Erwiniacarotovora* subsp.*carotovora*, which caused soft rot disease formany of horticultural crops,were obtained from different locations as follows:

E_1 and E_2: from MIRCEN, Faculty of Agriculture, Ain Shams University.

E_3 and E_4: from Department of Plant Pathology, Faculty of Agriculture, Damanhour University.

E_5, E_6 and E_7: from Department of Plant Pathology, Faculty of Agriculture, El-Shatby, Alexandria University.

E_8: from Department of Plant Pathology, Faculty of Agriculture, Kafr El-Sheikh University.

E_9 and E_{10}: from Department of Plant Pathology, Agricultural Research Station, Itay El Baroud.

Laboratory experiment: it was conducted to examine the efficiency of two bactericides namely streptrol and oxolinic acid at different concentrations i.e., 5, 20, 40, 50, 60, 80, 100 ppm against ten bacteria isolates. The disc plate method was used to screen the inhibitory effect of the tested bactericides against different isolates according to the methods of Loo *et al*., (1945) and Thornbeery (1950).

Plates of nutrient dextrose agar medium were inoculated with each isolate by spreading 1ml of bacteria suspension. Filter paper discs were impregnated with different concentrations of each bactericide, and placed into the surface of inoculated plates. The plates were incubated at 28±2 ºC for 72h. Three replicates discs were prepared from each concentration of bactericide. Check filter paper discs were placed on the surface of inoculated plates after impregnating within sterile water as control. Diameter of inhibition zone around the disc was measured in centimeters and the means were calculated.

Greenhouse experiment: the treatments of this stage of the investigation were depending on the results of the laboratory experiment for examining the efficiency of the most effective concentration of each of streptrol and oxolinic acid against the most two sensitive and the most two resistance *Erwiniacarotovora* subsp. *carotovora* isolates obtained from the disc plate test.

The potato seed tubers cv. "Sponta" were planted on 50 cm plastic pots filled with 12 kg of clay soil for each one in 10^{th} and 16^{th} of January, 2015 and 2016, respectively.Each pot was inoculated with suspension of each of selected four bacterial isolates of 24 hr old*Erwiniacarotovora* subsp. *carotovora* before three days of planting with retaining pots without bacterial infection. Potato seed tubers were dippedin each of the two bactericides for five minutes withthe most effective concentration which resulted from the laboratory experiment and planted in the pots. Untreated seed tubers were planted as control. Each pot was planted with one piece of potato. Five pots were used as replicates for each treatment.

The experimental layout was split-plotsin a randomized complete blocks design. The bactericide applications (control, streptrol and oxolinic acid) occupied the main plots and the selected erwinia isolates, in addition to uninfected ones, occupied the sub plots. The vegetative growth characters as plant height (cm), shoots number plant^{-1}, shoots fresh weight (cm), shoots dry weight (cm) and leaves chlorophyll using SPAD chlorophyll meterwere taken after 45 days from planting. While, the yield characters as tubers number plant^{-1} and tubers yield plant^{-1} (gm) and the tubers quality as total sugars(%) were determinedusing the phenol-sulfuric method as illustrated by Dubois *et al*.(1956), reducing sugars(%) were determined as the method described by Miller (1959), the non-reducing sugars that determined by subtracting the reducing from the total sugarsas well as starch (%) where estimated as shown by A.O.A.C (1980)after ending of each season.

Concerning the data on infection and loss of potato tubers yield due to soft rot were recorded and expressed as percentage using the formulas of AbdEl-Khair and Karima (2007).

Statistical analysis: All the obtained data were statistically analyzed using CoStat(Version 6.4, CoHort, USA, 1998–2008) program. Duncan's mutable range test at 0.05 probability level had been chosen for the comparisons between mean of the different treatments using the same program.

RESULTS AND DISCUSSION

Laboratory experiment

Data presented in Table (1) showed that the inhibition zone test revealed, generally, that the increase in bactericides concentration was correlated with the increase rate of inhibition bacterial growth. The most effective concentration of each of streptrol or oxolinic acid was found to be 100 ppm, which gave the highest inhibition zone with mean value of 3. 65 cm (Table 1). However, the using of streptrol was found to be more effective where it exhibited mean inhibition zone of 2.91 cm compared with 2.23 cm for the oxolinic acid with estimated percentage of 30.49%. These findings are found to be in line with Sathishkumar*et al*. (2010) results, who revealed that the increasing of Ag nanoparticles concentration was resulted in increasing the mean values of the inhibition zone of *E. coli* bacteria. Also, Nassar*et al*. (2013) who found that the streptrol had more antibacterial activity than oxolinic acid, which interpreted in significant increasing of its formed inhibition zone.

In the case of erwinia isolates, the results showed that the isolates showed general significant effect on the inhibition zone mean values. Also, the erwinia isolated namely E_2 and E_5 were the most sensitive isolates, which gave 3.28 and 3.38 cm, respectively. However, the erwinia isolates of E_7 and E_9 were the most resistance isolates regardless the used bactericides, which gave the lowest inhibition zone as 2.10 and 2.23 cm, respectively.These findings are in harmony with those of Cho *et al*. (2004) and Gallelli*et al*. (2009) that cleared significant differences in *Erwiniacarotovora* subsp. *Carotovora*resistance.

The interaction effect by using bactericides with erwinia isolates revealed that the highest mean values of inhibition zones were found with using streptrol or oxolinic acid at the highest concentration as 100 ppm with erwinia isolates of E_2 and E_5; while the erwinia isolates of E_7 and E_9 were give the lowest mean values of inhibition zone when treated with streptrol or oxolinic acid at 100 ppm (Fig. 1 and 2).

According to the results of these findings, the concentration to be used from the examined bactericides (streptrol and oxolinic acid) in the greenhouse is 100 ppm for each, while the bacterial isolates to be used are the two most sensitive isolates (E_2 and E_5) and the two most resistant isolates (E_7 and E_9) to the effect of these pesticides.

Table 1. The main effects of bactericides, bactericides concentrations and erwinia isolated on the inhibition zone mean values.

Main factors		Inhibition zone (cm)
Bactericides	Streptrol	2.91A
	Oxolinic acid	2.23B
Bactericides concentrations	0 ppm	0 G
	5 ppm	1.46 F
	20 ppm	1.70 E
	40 ppm	2.57 D
	60 ppm	3.12 C
	80 ppm	3.40 B
	100 ppm	3.65 A
Erwinia isolates	1	2.85 D
	2	3.28 B
	3	2.81 D
	4	3.03 C
	5	3.38 A
	6	2.37 G
	7	2.10 I
	8	2.54 F
	9	2.23 H
	10	2.68 E

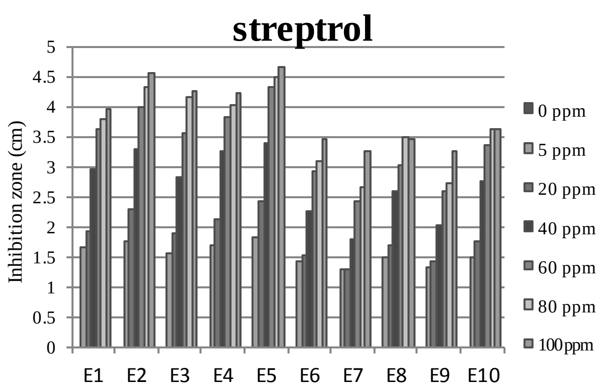

Figure 1. The interaction effects of erwinia isolates and streptrol bactericide concentration on the inhibition zone mean values.

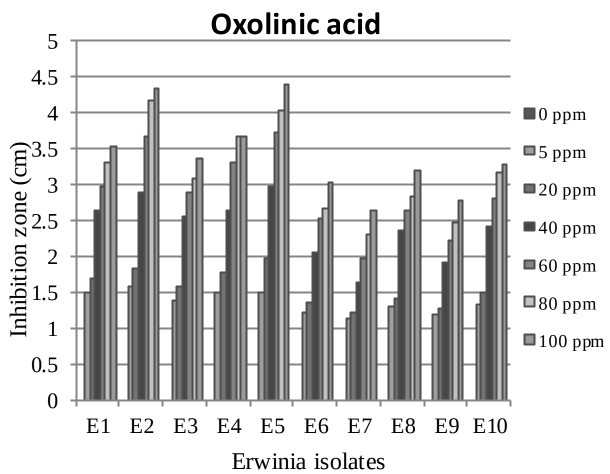

Figure 2. The interaction effects of erwinia isolates and oxolinic acid bactericide concentration on the inhibition zone mean values.

The greenhouse experiment

Growth and chlorophyll characters

The data in Table (2) illustrated the effect of bactericides, the selected erwinia isolates as well as their interactions on plant height, shoots number plant^{-1}, shoot fresh weight, shoot dry weight and leaves chlorophyll characters of potato plants.

Concerning the main effect of the tested bactericides, it was clearlythat the streptrol and oxolinic acid bactericides application gavesignificant effect on the above mentioned characters when compared with untreated control. However, the streptrol was found to give more significant enhancement effect when compared with oxolinic acid, for all the Table (2) characters, in both seasons of study.The average of both seasons of improvement percentages due to treatment with streptrol compared with control was found to be 36.73% for plant height, 39.21% for shoots number plant^{-1}, 23.65% for shoot fresh weight, 19.46% for shoot dry weight and 11.73% for leaves chlorophyll.

Whereas, the results showed thatthe uninfected plants (without) gave significant the highest mean values for the shown in Table (2) compared with potato plants that infected with any four tested erwinia isolates.Moreover, neither the erwinia isolates of E_2 and E_5nor the isolates of E_7 and E_9differ significantly fromeach other. Also, both of E_2 and E_5were found to give significant less harmful effect when compared with the isolates of E_7 and E_9. These findings were the same for all studied characters, in both seasons.

The effects of the interaction between bactericides and erwinia isolates, generally, were significant on all growth characters, in both seasons of study. The streptrol and oxolinic acid bactericides showed more effectiveness in controlling the soft rot disease compared with the control, which was reflected on significant increaseon various growth charactersover the infected and untreated potato plants (control), in both seasons of study.However, the streptrol was found to be, significantly, more effective than oxolinic acid in controlling the erwinia soft rot disease. Moreover, the isolates of E_2 and E_5 were found to be more sensitive than E_7 and E_9against the streptrol treatment, in both seasons of study.

Concerning the effect of the tested bactericides on the uninfected plants, it was clear that the shoot fresh weight showed significant and positive influence due to the streptrol or oxolinic acid applications. However, the same applications did not show any significant effect on all of the other studied growth characters listed in Table (2), in both seasons of study.

The enhancing effect of the pesticides application could be due to increasing the water content of the potato plants shoots (Güler, 2009). In the same context, each of Toscano *et al*. (1982) on lettuce and Haile *et al*. (1999) on alfalfa and soybean, they studied the effect of some different types of pesticides, which did not show any significant effect on the photosynthetic system or growth parameters of examined plants. Also, Preetha and Stanley (2012) did not found any significant influence of neonicotinoids insecticide on the leaves chlorophyll content of cotton and okra.

Yield characters

The results in Table (3) showed the effect of bactericides, the selected erwinia isolates and their interactions on tubers number plant^{-1}, tubers yield plant^{-1}, infection% and tuber yield loss% of the potato plants.

The main effect of the examined bactericides wassignificant compared with control treatment, in both seasonsof study. The data indicated, also, that the studied characters were generally favored with streptrol than with oxolinic acid.

Table 2. The main effects of erwinia isolates, bactericides and their interaction on plant height, shoots number plant^{-1}, shoots fresh weight, shoots dry weight and leaves chlorophyll characters of potato plants during 2015 - 2016 seasons.

Erwinia isolates (B)	Bactericides (A)							
	First season				Second season			
	Control	Streptrol	Oxolinic acid	Mean	Control	Streptrol	Oxolinic acid	Mean
	Plant height (cm)							
Untreated	31.56	33.1	30.82	31.82	33.01	35.30	33.22	33.85
E_2	22.52	31.50	29.64	27.89	23.96	34.71	29.84	29.50
E_5	21.55	31.56	30.43	27.85	22.96	33.89	32.62	29.82
E_7	20.52	29.18	27.70	25.80	19.56	31.09	30.44	27.03
E_9	19.47	28.61	27.33	25.14	18.56	30.63	30.56	26.58
Mean	23.12	30.79	29.18		23.61	33.12	31.34	
LSD	A= 0.98	B= 1.56	AB= 2.71		A= 1.45	B= 1.87	AB= 3.25	
	Shoots No. plant^{-1}							
Untreated	5.56	5.56	5.78	5.63	5.89	6.56	6.11	6.19
E_2	4.22	5.78	4.56	4.85	4.67	6.22	5.11	5.33
E_5	4.56	5.78	4.22	4.85	4.78	6.78	5.78	5.44
E_7	2.89	5.22	4.34	4.15	2.44	5.56	4.67	4.22
E_9	3.34	5.22	4.44	3.96	2.89	5.44	4.66	4.33
Mean	4.02	5.44	4.60		4.13	5.91	5.27	
LSD	A= 0.47	B= 0.62	AB= 1.07		A= 0.52	B= 0.74	AB= 1.27	
	Shoot fresh weight (gm)							
Untreated	129.12	142.54	140.64	137.44	137.42	159.03	154.54	150.33
E_2	113.04	145.12	137.92	132.03	122.60	154.64	136.86	138.03
E_5	115.60	143.11	138.15	132.29	122.05	146.57	145.36	137.99
E_7	108.22	140.23	135.77	128.07	109.05	144.19	139.01	130.75
E_9	109.80	140.35	136.89	128.85	113.91	143.64	132.45	130.00
Mean	115.06	142.27	137.87		121.00	149.61	141.64	
LSD	A= 3.02	B= 2.82	AB= 4.88		A= 7.74	B= 4.45	AB= 7.71	
	Shoot dry weight (gm)							
Untreated	30.20	30.58	31.70	30.83	30.63	32.20	30.06	30.96
E_2	24.78	26.66	26.02	25.82	22.44	26.70	26.24	25.13
E_5	23.83	26.87	25.70	25.80	22.81	28.01	25.17	25.33
E_7	23.55	25.23	25.11	24.63	19.81	26.08	23.22	23.04
E_9	22.30	27.19	24.06	24.52	20.71	25.36	23.28	23.12
Mean	24.33	28.14	26.29		21.94	27.04	24.98	
LSD	A= 1.60	B= 0.92	AB= 1.60		A= 1.63	B= 1.62	AB= 2.81	
	Leaves chlorophyll (SPAD)							
Untreated	59.55	60.32	58.51	59.46	58.59	61.82	60.79	60.40
E_2	53.17	58.32	55.58	55.69	52.09	59.66	56.63	56.13
E_5	53.08	61.00	56.94	57.01	53.05	59.06	56.28	56.13
E_7	46.62	57.79	52.63	52.35	48.26	54.22	51.54	51.34
E_9	47.52	56.71	52.69	52.31	51.02	55.27	51.47	52.59
Mean	51.99	58.83	55.27		52.60	58.01	55.34	
LSD	A= 3.00	B= 2.41	AB= 4.17		A= 1.90	B= 2.69	AB= 4.65	

The average of the two seasons increment percentages of tubers number plant^{-1} and tubers yield plant^{-1} characters due to streptrol application over the control were found to be 46.31 and 63.53%, respectively. Moreover, the streptrol causing significant reduction in infection% and tuber yield loss% by 64.56% and 51.37%, respectively. Such increment in tubers number plant^{-1} and tubers yield plant^{-1} may be a result of enhancement in growth characters of potato plants in addition to the increasing of leaves chlorophyll content due to streptrol treatment.

Regarding the results of the other main effect on tubers number plant^{-1}, tubers yield plant^{-1}, infection% and tuber yield loss% , the potato plants that did not received any infection with soft rot erwinia, clearly, showed significant superiority over the other potato plants that infected with nay of the tested isolates, in both seasons of study. Whereas, the four used erwinia isolates were found to have a negative significant effect on tubers number plant^{-1} and tubers yield plant^{-1} of potato plants, in both seasons of study. In the contrary, the different isolated causing significant increase in the mean values of infection% and tuber yield loss% compared with untreated plants. Moreover, the results showed that the erwinia isolates of E_7 and E_9gave the same effect on reducing tubers number plant^{-1} and tubers yield plant^{-1} and increasing infection% and tuber yield loss%, which weresignificantly more virulent if compared with E_2 and E_5, in both seasons of study.

The combined effect between bactericides and erwinia isolates are presented in Table (3). The results showed that interaction effect was found to be significant, in both seasons of study. Also, the streptrol gave significant enhancement intubers number plant^{-1} and tubers yield plant^{-1} and reduction in infection% and tuber yield loss% of the potato plants infected with the examined erwinia isolates when compared with using oxolinic acid, in most interaction cases.However, the untreated potato plants did not show any significant response due to the bactericides treatments if compared to the control, in both seasons.These insignificant effects of the used bactericides on the yield characters of potato plant could be derive from that they did not affect the growth characters.There were many other investigators reported insignificant effect of their examined pesticides on the yield and its components (Khan and Carlson, 2009 on sugar beet; Swoboda and Pedersen, 2009 on soybean; Bradley and Ames, 2010 on corn and Mahoney and Gillard, 2014 on dry bean).

Potato tubers quality

The listed values in Table (4) illustrated the maininfluence of each ofbactericides and the four selected erwinia isolates as well as their interactions on the estimated quality characters of potato tubers as reducing sugars, non-reducing sugars, total sugars and starch percentages.

Table 3. The main effects of erwinia isolates, bactericides and their interaction on tubers number plant^{-1} and tubers yield plant^{-1} characters of potato plants during 2015 - 2016 seasons.

Erwinia isolates (B)	Bactericides (A)							
	First season				Second season			
	Control	Streptrol	Oxolinic acid	Mean	Control	Streptrol	Oxolinic acid	Mean
	Tubers No. plant^{-1}							
Untreated	12.22	12.45	12.11	12.26	12.44	12.22	12.33	12.33
E_2	7.67	12.00	8.33	9.33	5.56	10.11	10.78	8.82
E_5	8.44	11.22	8.56	9.41	6.44	10.89	8.00	8.44
E_7	4.89	9.56	8.56	7.67	4.44	8.89	7.55	6.96
E_9	4.81	9.67	8.78	7.75	5.56	9.00	5.78	6.78
Mean	7.61	10.98	9.27		6.89	10.22	8.89	
LSD	A= 0.57 B= 0.81 AB= 1.41				A= 0.62 B= 0.98 AB= 1.69			
	Infection%							
Untreated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E_2	23.62	10.83	16.79	17.08	34.32	13.48	14.26	20.69
E_5	20.59	10.73	17.15	16.16	28.32	13.45	20.04	20.60
E_7	62.84	17.44	23.45	34.58	66.94	20.24	29.97	39.05
E_9	61.25	19.42	22.19	34.29	60.13	21.46	35.03	38.87
Mean	33.66	11.68	15.92		37.94	13.73	19.86	
LSD	A= 1.08 B= 1.76 AB= 3.05				A= 4.02 B= 3.62 AB= 6.27			
	Tubers yield plant^{-1}							
Untreated	487.65	493.04	482.29	487.66	371.58	402.11	414.76	396.15
E_2	243.15	489.13	369.47	367.45	246.26	419.30	360.79	342.12
E_5	267.43	486.50	373.40	375.78	257.61	414.98	362.22	344.94
E_7	174.65	457.71	387.45	339.94	161.93	373.66	350.73	295.44
E_9	191.23	479.64	358.08	342.98	253.13	334.52	350.84	312.83
Mean	272.82	481.20	394.14		258.10	388.91	367.87	
LSD	A= 14.29 B= 10.84 AB= 18.77				A= 18.65 B= 26.06 AB= 45.13			
	Tubers yield loss%							
Untreated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E_2	29.39	11.88	15.92	19.06	29.27	12.14	16.14	19.19
E_5	27.39	11.04	13.87	17.44	27.84	12.11	14.88	18.28
E_7	41.38	23.16	25.57	30.04	41.36	23.51	25.99	30.29
E_9	41.62	20.01	24.09	28.57	40.39	21.64	25.75	29.26
Mean	27.96	13.22	15.89		27.77	13.88	16.55	
LSD	A= 1.80 B= 1.67 AB= 2.89				A= 1.80 B= 1.67 AB= 2.89			

The main effect of the used bactericides on the above mentioned characters was found to be significant, in both seasons of study.It was found that both pesticides had reduced the percentage of reducing sugars, non-reducing sugars and total sugars; whereas, increased the starch percentage of the potato tubers when compared with control, in both seasons of study. However, the treatment of streptrol was significantly effective comparing with oxolinic acid for all of tubers quality characters. Comparing with the control, the streptrol treatment was resulted in reduction percentages for reducing sugars, non-reducing sugars and total sugars of potato tubers as 38.43, 41.19 and 44.31%, respectively as averages of both seasons.While, the same treatment was found to increase the starch content of potato tubers comparing with the control that estimated by 17.91% as an average of both seasons of study.

In the case of erwinia isolates, the results in Table (4) showed significanteffect on all of the studied potato tubers quality parameters, in both seasons of study. Among these treatments, the results showed that the untreated potato plants exhibited the lowest significant mean values oftubers reducing sugars, non-reducing sugars and total sugars and the highest significant mean value of tubers starch comparing with all other erwinia isolates, in both seasons of study.

Moreover, the results revealed that the isolates of E_7 and E_9 were resulted in the same significant increasing in potato tubers reducing sugars, non-reducing sugars and total sugars when compared with E_2 and E_5isolates, in both seasons of study. In the contrary, the tubers of potato plants that infected with erwinia isolates of E_2 and E_5were have more starch content comparing with E_7 and E_9isolates.

The interaction effect between the two main factors was found to be significant for all tubers quality traits, in both seasons of study. Moreover, the using of streptrol was found to be more effective than oxolinic acid in the face of different bacterial isolates. Under each bactericide, the bacterial isolated did not exhibit significant influence on the studied characters, in most interaction cases.

On the other hand, the tubers quality characters of untreated potato plants did not show any significant effect according to the used bactericide, in both seasons of study.This result may be due to the insignificant role of the used bactericides in increasing the leaves chlorophyll content and dry matter production as mentioned before, which reflects on the quality characters of the potato tubers. In the same context, Khan and Carlson (2009) on sugar beet were published that the application of some fungicides did not affecting, significantly, the sucrose concentrations of sugar beet roots.

Table 4. The main effects of erwinia isolates, bactericides and their interaction on tuber reducing sugars, non-reducing sugars, total sugars and starch contnets of potato plants during 2015 - 2016 seasons.

Erwinia isolates	First season				Second season			
	Control	**Streptrol**	**Oxolinic acid**	**Mean**	**control**	**Streptrol**	**Oxolinic acid**	**Mean**
	Reducing sugars							
Untreated	0.271	0.285	0.278	0.278	0.332	0.260	0.269	0.287
E_2	0.773	0.536	0.734	0.681	0.610	0.345	0.525	0.493
E_5	0.752	0.547	0.642	0.647	0.610	0.320	0.485	0.472
E_7	0.951	0.599	0.737	0.762	0.835	0.380	0.505	0.573
E_9	0.953	0.578	0.740	0.757	0.756	0.404	0.523	0.561
Mean	0.740	0.509	0.626		0.629	0.342	0.461	
LSD	A= 0.081	B= 0.063	AB= 0.109		A= 0.066	B= 0. 061	AB= 0.107	
	Non-reducing sugars							
Untreated	0.571	0.572	0.501	0.548	0.453	0.440	0.465	0.453
E_2	1.173	0.602	0.782	0.852	0.990	0.527	0.731	0.750
E_5	1.293	0.625	0.989	0.969	0.958	0.515	0.717	0.730
E_7	1.624	0.770	1.167	1.187	1.159	0.657	0.894	0.904
E_9	1.490	0.594	1.140	1.195	1.098	0.672	0.864	0.878
Mean	1.230	0.705	0.916		0.932	0.562	0.734	
LSD	A= 0.165	B= 0.184	AB= 0.319		A= 0.112	B= 0.103	AB= 0.179	
	Total sugars							
Untreated	0.842	0.857	0.779	0.826	0.785	0.699	0.733	0.739
E_2	1.515	0.708	1.087	1.103	1.600	0.872	1.256	1.243
E_5	1.616	0.724	1.201	1.186	1.568	0.835	1.200	1.201
E_7	2.145	0.938	1.473	1.519	1.994	1.037	1.400	1.477
E_9	2.014	1.101	1.450	1.522	1.855	1.076	1.387	1.439
Mean	1.626	0.869	1.198		1.560	0.904	1.196	
LSD	A= 0.172	B= 0.214	AB= 0.371		A= 0.074	B= 0.131	AB= 0.227	
	Starch%							
Untreated	59.97	59.93	59.51	59.80	57.26	60.52	59.14	58.98
E_2	54.23	60.59	53.10	55.97	48.60	59.63	56.49	55.63
E_5	51.07	61.91	57.31	56.76	50.01	62.25	54.65	54.91
E_7	45.33	53.48	52.49	50.43	41.07	53.71	53.78	49.52
E_9	46.26	55.00	56.29	52.52	40.24	54.61	50.58	48.48
Mean	51.37	58.18	55.74		47.44	58.14	54.93	
LSD	A= 2.13	B= 2.98	AB= 5.16		A= 2.16	B= 3.06	AB= 5.30	

It could be concluded that the application of 100 ppm of streptrol could provide very effective treatments for controlling soft rot disease, whereas, the oxolinic acid may considered as the second option. However, they do not have any secondary effects on the growth, yield and tubers quality characters of the potato crop.

And therefore, it is not recommended to use such bactericides in the non-propose of controlling the soft rot disease.

REFERENCES

A.O.A.C. 1980.Official Methods of Analysis.Association of Official Agricultural Chemists, Bed., Washington, D.C.P. 1018.

Abd-El-Khair, H. and H.E.H. Karima. 2007. Application of some bactericides and bioagents for controlling the soft rot disease in potato. Res. J. Agric. Biol. Sci., 3(5): 463-473.

Ageichik, A.V.;A.N. Evtushenkov and Y.A. Nikolaichik. 2002. The Role of Type III Secretion System in *Erwiniacarotovora* subsp. *atroseptica* Virulence. Proc. 6th Conf. EFPP 2002, Prague. Plant Protect. Sci., 38 (Special Issue 2): 523–527.

Amengor, M.G. and F.M. Tetteh. 2008. Effect of pesticide application rate on yield of vegetables and soil microbial communities. West Afr. J. Appl. ecology, 12.

Basantani, M.; A. Srivastava and S. Sen. 2011. Elevated antioxidant response and induction of tau-class glutathione S-transferase after glyphosate treatment in *Vignaradiata* (L.)Wilczek.Pest.Biochem. Physiol., 99: 111-117.

Bashir, F.; T.O. Siddiqi and M. Iqbal. 2007. The antioxidative response system in *Glycine max* (L.) Merr.Exposed to Deltamethrin, a synthetic pyrethroid insecticide. Environ. Poll., 147(1): 94-100.

Bradley, C.A. and K.A. Ames. 2010. Effect of foliar fungicides on corn with simulated hail damage. Pl. Disease, 94(1): 83-86.

Cho HR, Lim JH, Yun KJ, Snijder RC, Goo DH, Rhee HK, Kim KS, Joung HY. Virulence variation in 20 isolates of Erwiniacarotovora subsp. carotovora on Zantedeschia cultivars in Korea.InIX International Symposium on Flower Bulbs 673 2004 Apr 19 (pp. 653-659).

CoStat Program, 2008. Disclaimer and License for CoStat 6.4. Cohort Software Inc., Monterey, CA, USA.

Debergh, P.D.; G De Coster and W. Steurbaut. 1993. Carbendazim as an alternative plant growth regulator in tissue culture systems. In Vitro Cell. Develop. Biol. Pl., 29 (2): 89-91.

Dubois, M.; K.A.Gilles; J.K. Hamilton; P.T.Rebersand F. Smith. 1956. Colorimetric method for determination of sugars and related substances. Analytical chemistry, 28(3): 350-356.

El-Bessomy, M.A.M. 1993. The influence of pesticides types on vegetables quality. Ph.D. Thesis, Fac. Agric., Alex. Univ.

FAOSTAT Database, a website. *Available at:*http:// faostat3.fao.org/home/E

Fiers, M.; V. Edel-Hermann; C. Chatot; Y. Le Hingrat; C. Alabouvette and C. Steinberg. 2012. Potato soil-borne diseases. A review. Agron. Sustain. Develop., 32(1): 93-132.

Gaikwad, S.B.; M.B. Chetti and D.I. Jirali. 2017. Influence of Different Pesticides on Chemical, Biochemical and Yield Parameters of Brinjal (*Solanummelongena* L.). J. Pl. Biochem. Physiol., 5 (4) [DOI: 10.4172/2329-9029.1000201].

Gallelli, A.; M.Galli; D.De Simone;Zaccardelli M. andS.Loreti. 2009. Phenotypic and genetic variability of *Pectobacteriumcarotovorum* isolated from artichoke in the Sele valley. J. Pl. Path., 91(3): 757-761.

García, P.C.; R.M. Rivero; J.M. Ruiz and L. Romero. 2003. The role of fungicides in the physiology of higher plants: implications for defense responses. Bot. Rev., 69(2): 162-172.

Goré; B.B., J.P. Baudoin, and B.I. Zoro. 2011. Effects of the numbers of foliar insecticide applications on the production of the oilseed watermelon *citrulluslanatus*. Sci. Nature, 8(1-2): 53-62.

Güler, S. 2009. Effects of nitrogen on yield and chlorophyll of potato (*Solanumtuberosum* L.) cultivars. Bangladesh J. Bot., 38(2): 163-169.

Haile F.J.; Peterson R.K.D. and L.G. Higley. 1999. Gas-Exchange Responses of Alfalfa and Soybean Treated with Insecticides. J. Econ. Entom., 92 (4): 954-959.

Hongtao, J.; D. Jin-ding and L. Feng-lian. 2003. Physiological function mechanism and application of multi-effect triazole. J. Anhui Agric. Sci., 31(2): 323-324.

Horst, R.K. 2013.Bactericides.In Westcott's Plant Disease Handbook (pp. 13-14). Springer, Dordrecht.

Ilieva, A. and V. Vasileva. 2014. Effect of pre-sowing treatment of seeds with insecticides on parameters related to nodulation and nitrate reduction in soybean [*Glycine max* (L.) Merr.]. J. Cent. Eur. Agric., 15(2): 23-32.

Kabeil, S.S.; S.M. Lashin; M.H. El-Masry; M.A. El-Saadani; M.M. Abd-Elgawad and A.M. Aboul-Einean. 2008. Potato brown rot disease in Egypt: current status and prospects. Am-Eurasian J. Agric. Environ. Sci.; 4 (1): 44-54.

Karthikeyan, R.; L.C. Davis; L.E. Erickson; K. Al-Khatib; P.A. Kulakow; P.L. Barnes.; S.L. Hutchinson and A.A. Nurzhanova. 2003. Studies on responses of non-target plants to pesticides: A. Hazardous Substance Research Center, Kansas State University, Lawrence, p.10.

Khan, M.F.R. and A.L. Carlson. 2009. Effect of fungicides on sugar beet yield, quality, and postharvest respiration rates in the absence of disease. Plant Health Progress, doi: 10.1094/PHP-2009-1019-01-RS.

Krugh, B.W. and D Miles. 1996. Monitoring the effects of five "nonherbicidal" pesticide chemicals on terrestrial plants using chlorophyll fluorescence. Environ. Toxic. Chem., 15(4): 495–500.

Loo, Y.H.; P.S. Skell; H.H. Thornberry; J. Ehrlich; J.M. McGuire; G.M. Savage and J.C. Sylvester. 1945. Assay of streptomycin by the paper-disc plate method. J. Bacteriol., 50(6):701.

Mahoney, K. J. and C. L. Gillard. 2014. Plant health and yield of dry bean not affected by strobilurin fungicides under disease-free or simulated hail conditions. Can. J. Pl. Sci., 94(8):1385-1389

Mendez, R.M. and B. Manuel. 2014. Studies on the tolerance of *Vignasinensis* L. and *Oryza Sativa* L. to the application of pesticides. ISOSR J. Environ. Sci., Toxic. Food Techn., 8(6): 13-18.

Miller, G.I. (1959). Use of dinitrosalicylic acid reagent for the determination of reducing sugars. Analytical Chem., 31: 426–428.

Mishra, V.; G. Srivastava, S.M. Prasad and G. Abraham. 2008. Growth, photosynthetic pigments and photosynthetic activity during seedling stage of cowpea (*Vignaunguiculata*) in response to UV-B and dimethoate. Pest.Biochem. Physiol., 92: 30-37.

Moore, M.T. and R. Kroger. 2010. Effect of three insecticides and two herbicides on rice (*Oryza sativa*) seedling germination and growth. Arch. Environ. Contam.Toxicol., 59: 574-581.

Nassar, A.M.; M.A. Abbassy; S.A. Masoud and M.M. Ghoneim. 2013. Natural extracts of mushroom and garlic as bactericide alternatives against potato soft-rot bacteria, *Erwinia carotovora* subsp. *carotovora*. J. Agric. Environ. Sci., Damanhour Univ., Egypt.

Parashar, R.D. and G.S. Sindhan. 1988. Efficacy of klorocin and other chemicals in controlling soft rot of potato in field and storage. Ind. J. Mycol. Pl. Pathol., 18(1): 39-42.

Preetha, G. and Stanley. 2012. Influence of neonicotinoid insecticides on the plant growth attributes of cotton and okra. J. pl. Nutr., 35(8): 1234-1245.

Rajashekhar, N.P. and T.C.S. Murthy, 2012.Seed germination and physiological behavior of Maize (cv. Nac-6002) seedlings under abiotic stress (Pendimethalin) condition. Asian J. Crop Sci., 4(2): 80.

Sathishkumar, M., Sneha, K. and Yun, Y.S., 2010.Immobilization of silver nanoparticles synthesized using *Curcuma longa* tuber powder and extract on cotton cloth for bactericidal activity. Bioresource tech., 101(20): 7958-7965.

Sergiev, I.G.; V.S. Alexieva; S.V. Ivanov; I.A. Moskova and E.N. Karanov, 2006. The phenylureacytokinin 4PU-30 protects maize plants against glyphosateaction, Pestic. Biochem. Physiol.. 85:139–146.

Shields, R.; S.J. Robinson and P.A. Anslow. 1984. Use of fungicides in plant tissue culture. Pl. Cell Rep., 3(1): 33-36.

Shtienberg, D.; M. Zilberstaine; D. Oppenheim; Z. Herzog; S. Manulis; H. Shwartz and G. Kritzman. 2001. Efficacy of oxolinic acid and other bactericides in suppression of *Erwiniaamylovora* in pear orchards in Israel. Phytoparasitica, 29(2): 143-154.

Swoboda, C. and P. Pedersen. 2009. Effect of fungicide on soybean growth and yield. Agron. J., 101(2): 352-356.

Thornberry, H.H. 1950. A paper-disk plate method for the quantitative evaluation of fungicides and bactericides. Phytopathol., 40 (5).

Tiyagi, S.A.; S. Ajaz and M.F. Azam. 2004. Effect of some pesticides on plant growth, root nodulation and chlorophyll content of chickpea. *Archives of* Agron. Soil Sci., 50(6): 529-533.

Toscano, N.C.; F.V. Sances; M.W. Johnson and L.F. lapre. 1982. Effect of various pesticides on lettuce physiology and yield. J. Econ. Entomol., 75(4): 738-741.

Woda, L.M. 1994. Biochemical changes in potato plants under the influence of cabfuran (Furadan 5G) and metribuzin (Sencor). Prace Naukawe Instytutu OchronyRoslin. 35 (1-2): 80-84 (c.f. CAB direct database)

Yahong, S.M.S.Y.S.; L.Z.C. Huifang; T. Youwei; S. Yuguang and G. Huiqin. 1991. Stimulation effect of MET on growth of potato tubers. ActaAgric Shanghai, 1: 13.

Yoon, J.Y.; J.S. Shin; D.Y. Shin; K.H. Hyun; N.R. Burgos and L. Sungbeom. 2011. Tolerance to paraquat-mediated oxidative and environmental stresses in squash (*Cucurbita* spp.) Leaves of various ages.Pest.Biochem. Physiol., 99: 65–76.

Youngman, R.R.; T.F. Leigh; T.A. Kerby; N.C. Toscano and C.E. Jackson. 1990. Pesticides and cotton: effect on photosynthesis, growth, and fruiting. J. Econ. Entomol., 83(4): 1549-1557.

كفاءة الستريبترول وحامض الأوكسولينيك في مكافحة العفن الطري في البطاطس و تأثيراتهما الثانوية على النمو و المحصول و صفات الجودة

علاء الدين حسين رشدي[1]، سناء عبد الله مسعود[2] و صبحى عبد الرحيم حامد[3]

[1] قسم البساتين – كلية الزراعة – جامعة دمنهور

[2] المعمل المركزي للمبيدات – مركز البحوث الزراعية – إيتاي البارود

[3] قسم وقاية النبات (كيمياء وسمية المبيدات) – كلية الزراعة – جامعة طنطا

تم إجراء تجربتين متعاقبتين,الأولى كانت تجربة معملية لدراسة أفضل تأثير مضاد للبكتريا لكل من الستريبترول وحامض الأوكزولينك بناءً على مناطق التثبيط على 10 عزلات مختلفة من *Erwiniacarotovora* subsp. *carotovora*. أظهرت النتائج أن تركيز 100 جزء في المليون من كل الستريبترول أو حمض الأوكزولينك أعطى أعلى منطقة تثبيط مع تفوق كبيرمن الستربتيرول مقارنة بحمض الأكزولينك بنسبة تقدر بـ 30,49%. أظهرت النتائج أن عزلات الإروينيا E_2 و E_5 هي الأكثر حساسية. بينما كانت عزلات E_7 و E_9 هي الأكثرمقاومة بغض النظرعن المبيدات البكتيرية المستخدمة وفقًا لمناطق التثبيط. التجربة الثانية كانت فى الصوبة الزراعية لدراسة تأثيرحمض الستريبترول وحمض الأكزولينك بتركيز 100 جزء فى المليون على نباتات البطاطس المصابة بكل من عزلات E_2 و E_5 و E_7 و E_9 من الإروينيا ، بالإضافة إلى البطاطس غيرالمصابة لدراسة الآثار الثانوية لتطبيق مبيدات البكتريا على نمو ومحصول وجودة نباتات البطاطس. أظهرت التجربة أن عزلات الإروينيا E_7 و E_9 تسببت فى خفض متوسطات قيم الصفات المدروسة مقارنة بالعزلات E_2 و E_5 ، فى موسمى2015 و 2016. بينما أعطى الستريبترو ل بتركيز 100 جزء فى المليون أعلى تأثير مضاد للبكتريا بغض النظرعن العزلات المستخدمة. ايضا أظهرت النتائج أن كل من الستريبترول أو حمض الأكزولينك لم يُظهر أي تأثيرات ثانوية معنوية على جميع الصفات المدروسة بإستثناء وزن المجموع الخضري الطازج في كلا موسمي الدراسة.