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POPULATION FLUCTUATIONS OF THE POTATO TUBER MOTH LARVAE IN EARLY POTATO SUMMER PLANTATION AND EFFECT OF SOME TOXIC COMPOUNDS ON LEAF CHLOROPHYLL CONTENT AND POTATO TUBERS IN STORES

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ABSTRACT: *Experiments were carried out at Shennow locality Kafr El-Sheikh and Atawa, Al- Gharbiya governorates (Delta region), early potato summer plantation with potato var. (Diamant) in 2014 season. To survey pests attacked potato and associated predators and the population fluctuations of the potato tuber moth. Also, efficiencies of certain compounds; Malathate, Match, Penny, Deltarab, Proclaim, Dipel 2x and Protecto in reducing its populations and chlorophyll content in potato leaves were evaluated. In addition, efficiency of Dipel 2x and Protecto to control the PTM on potato tubers in stores were evaluated. The investigation revealed the presence of 12 species, nine families and six orders as pests on potato plants. Aphids constituted the greatest number followed by Phthorimaea operculella (Zeller), while Nezara viridula (L.) was recorded in few numbers. The surveyed predators, seven species, six families and five orders were recorded. Scymnus sp. constituted the greatest in number, while Paederus alfierii (Koch) was recorded in few numbers. The highest population densities of P. operculella larvae were recorded in April and May at Kafr El-Sheikh and March, April and May at Al-Gharbiya. Dipel 2 x and Match was the most potent compound in reducing the population density of potato tuber moth larvae followed by Proclaim, while Protecto showed a low effect at Kafr El-Sheikh. At Al-Gharbiya governorate, Proclaim and Dipel 2 x were the most potent compounds in reducing the population density of potato tuber moth larvae, followed by Deltarab but Protecto showed a low effect. The chlorophyll content grand average increased significantly by Dipel 2x treatment. In Al-Gharbiya, chlorophyll content (SPAD) recorded the highest level with Protecto and Match treatments, while it was the least with Proclaim treatment in potato leaves. In addition, Dipel 2x and Protecto gave satisfactory results against tuber infestations (P. operculella) in stores.*

Key words: *Pests, predators, the potato tuber moth, potato plantation, compounds, chlorophyll content, tuber, store*

INTRODUCTION

The potato, *Solanum tuberosum* L. is the second most important vegetable crops grown in Egypt after tomato, for local consumption, export and processing. The area cultivated with potato about 2,002 acres producing about 2.2 million tons (Hegazi, 2011). In the field, potato plants are attacked by several pests such as aphids, thrips, leafhopper, the potato tuber moth, the tomato leaf miner and associated predators (El-Sheikh and El-Nagar, 1994, Abd El-Fattah *et al*., 2000, El-Khawas and Shoeb, 2004, Golizadeh, *et al.,* 2012 and Desoky, 2015).

The potato tuber moth (PTM), is one of the most important pests which damage potato tubers in the field and during storage in many countries. This pest attacks solanaceous crops throughtout the year, in Egypt. Larvae of this species mine leaves, stems, and petioles and excavate tunnels through potato tubers (Rondon *et al*., 2007).

Farmers routinely rely on chemical insecticides that could be hazardous for human health and environment. Insecticide resistance of PTM has been reported all over the world, so botanical origin materials may serve as proper alternative materials for controlling the pest. Natural products are generally preferred because they are less harmful to non-target organisms, eco-friendly and biodegradable (Rafiee-Dastjerdi *et al.,* 2014). The bacterial pathogen *Bacillus thuringiensis* (Bt) is considered as most common microbial insecticide, which largely applied against the PTM in stored potato (Thakur and Chandla 2013). Dipel2x is a highly selective biological insecticide of Bt for use against caterpillars (Gomaa, 2007). A single pre- storage application of Dipel2x gave a similar level of protection resulted from eight applications of the synthetic pyrethroid, Fenvalerate that applied every 15 day (Gomaa, 2007). Dobie (2010) found that methamidophos, indoxacarb, and esfenvalerate were caused mortality of *P. operculella* for about five days after application. Abdel-Razek *et al.* (2014) found that Nimbecidine and Bio-power treatments against PTM, reduced the larval mine after 3 applications in field.

The objective of this work was to survey pests and predators associated early potato summer plantation and monitor the population fluctuations of the potato tuber moth at Kafr El-Sheikh and Al- Gharbiya governorates. Also, efficiencies of certain compounds; Malathate, Match, Penny, Deltarab, Proclaim, Dipel 2x and protecto in reducing the population density of the potato tuber moth and chlorophyll content in potato leaves were evaluated. In addition, efficiency of Dipel 2x and Protecto to control PTM on potato tubers in stores were investigated.

MATERIALS AND METHODS

Survey of pests, predators and the population fluctuations of *Phthorimaea operculella* larvae in early potato summer plantation:

Potato tubers were sown on January 15th, in two locations at Shennow locality Kafr El-Sheikh and Atawa, Al- Gharbiya governorates in 2014 season with cv. Diamant. An area of about one feddan was divided into four equal plots (considered as four replicates). Inspection started 40 days after sowing, and continued weekly till the end of the crop season. Numbers of pests were counted on 30 leaves taken from 10 plants/replicate (leaves picked up from lower, middle and upper levels). Predators were also counted on 10 plants/replicate in the field. The same samples were taken to laboratory to count the number of eggs and immature stages of whitefly and eggs, & mobile stages of *Tetranychus* sp. using binocular microscope were investigated.

Toxicity of the tested compounds against *Phthorimaea operculella* larvae:

The efficiency of seven compounds and control against *Phthorimaea operculella* larvae was evaluated in experimental area which was divided 32 plots, each 50 m^2. The treatments were arranged in a randomized complete block design with four replicates. The tested compounds were applied at recommended rates using a knapsack motor sprayer. These compounds were sprayed on May 4th in the first spray & 14th in the second spray at, Kafr El-Sheikh and, May 6th in the first spray & 16th in the second spray at Al-Gharbiya governorates in 2014 season.The tested compounds and rate of applications were:

A. Insecticides:

1-Malathion (Malathate 57% EC) at 2 L/ feddan.

2-Lufenuron (Match 5 % EC) at 160 ml/ feddan.

3-Emamectin benzoate 1.5% + indoxacarb 7.5 % (Penny 9% SC) at 200 ml/ feddan.

4- Indoxacarb (Deltarab 15 % SC) at 26ml/ 100 L water.

5- Emamectin benzoate (Proclaim 5 % WG) at 60 g/ feddan.

B. Bioinsecticides:

- *Bacillus thuringiensis* :

1- (Dipel2x 6.4 % WP) at 200 g/ feddan.

2- (Protecto 9.4 % WP) at 150 g/ feddan.

Counts of *P. operculella* larvae were recorded before spraying on 40 potato plants. Counts were also recorded after 10 days of the first spray and 10 days of the second spray. Percentage of population reductions were calculated according to Flemings and Ratnataran (1985) equation.

Chlorophyll content of potato leaves

Chlorophyll content of potato leaves was measured in SPAD, after 10 days of the first spray and 10 days of the second spray (tested compounds) a portable leaf chlorophyll meter (Minolta) (Marquard and Timpton, 1987) on the recently fully expanded leaf.

Effect of Dipel2x and Protecto to control the PTM on potato tubers in stores:

An experiment was conducted in 2014 and 2015 to evaluate the efficiency of *Bacillus thuringinsis* (Bt), Dipel2x 6.4 % WP and Protecto 9.4 % WP at 150 g / ton of potato tubers, in stores and the farmer traditional method by covering the stored potato tubers with a thick layer (0.5 m) of rice straw, in field of private farm at Shennow locality, Kafr El-Sheikh and Atawa, Al- Gharbiya governorates. Potato tubers were carefully stored after harvest on May 30, 2014 and 2015, treated with Dipel2x and Protecto compounds on June 15, in 2014 and 2015. Compounds were applied by trigger spray using low volume of water as 1.5 L/ton. Treated rice straw was used to cover the potato tubers, at 4 weeks intervals on a sample of 100 tubers, replicated four times. The infested tubers due to the PTM infestation for each treatment were counted and recorded after every sorting. Tubers that have infestations were sorted out of each pile after every inspection. Temperature was around 28^{o}c and relative humidity 65%. Percentage of infestation reductions was calculated according to Flemings and Ratnataran (1985) equation.

RESULTS AND DISCUSSION

1. Survey of pests and predators occurring in early potato summer plantation

Table (1) shows the pests found in early potato summer plantation in 2014 season at Kafr El-Sheikh and Al-Gharbiya governorates. Data revealed the presence of 12 species, nine families and six orders were recorded as pests on potato plants. These pests were aphids; *Myzus persicae* Sulzer, *Aphis gossypii* Glover, and *Macrosiphum* sp., *Phthorimaea operculella* (Zeller), *Thrips tabaci* Lind., *Empoasca* spp., *Bemisia tabaci* Genn., *Tuta absoluta* (Meyrick), *Tetranychus* sp., *Liriomyza* sp., semi looper worms and *Nezara viridula* (L). Aphids constituted the greatest in number. Population density of aphids per 30 leaves was forming about 30.66 and 31.86 % of the total pests at Kafr El-Sheikh and Al-Gharbiya, respectively. It was followed by *P. operculella* recording 20.20 and 24.54%. *T. tabaci* and *Empoasca* spp.were the third rank and recording 19.36 & 14.57% and 15.0 and 11.67% at Kafr El-Sheikh and Al-Gharbiya, respectively, while *N. viridula* was represented as lowest number.

Results showed also, seven species, *Scymnus* sp., *Coccinella undecimpunctata* L., *Chrysoperla carnea, Orius* sp., Syrphidae, *Paederus alfierii* (koch), and spiders. As for predators, *Scymnus* spp. constituted the greatest in number, with forming about 34.08 and 41.59% per 10 plants at Kafr El-Sheikh and Al-Gharbiya, respectively (Table,1). The next common species on potato plant was *C. undecimpunctata* which represented about 28.70 and 35.34%. *C. carnea* and spiders occupied the third rank while *P. alfierii* was the last one (Table,1).

Table (1): Population density of pests and their associated predators in early potato summer plantation in 2014 season

Order/Family	Genus/species	Stage	Location			
			Kafr El-Sheikh		Al-Gharbiya	
			No.	Occurrence %	No.	Occurrence %
Pests			Average No./30 leaves			
Hemiptera, Homiptera	*Aphis gossypii* Glover					
Aphididae	*Myzus persicae* Sulzer *Macrosiphum* sp.	N,A	146.14	30.66	218.71	31.86
Aleyrodidae	*Bemisia tabaci* Genn.	N,A	38.57	8.09	53.29	7.76
Cicadellidae	*Empoasca* spp.	N,A	71.50	15.00	80.14	11.67
Lepidoptera						
Gelechiidae	*Phthorimaea operculella* (Zeller)	L	96.29	20.20	168.5	24.54
	Tuta absoluta (Meyrick)	L	7.93	1.66	35.79	5.21
Noctuidae	(Semi looper worms)	L	3.64	0.76	5.00	0.73
Hemiptera						
Pentatomidae	*Nezara viridula* (L)	N,A	3.43	0.72	3.93	0.57
Diptera	*Liriomyza* sp.	L	5.79	1.12	6.86	1.00
Agromyzidae						
Thysanoptera						
Thripidae	*Thrips tabaci* Lind.	N,A	92.29	19.36	100.0	14.57
Acarina						
Tetranychidae	*Tetranychus* sp.	E,M	11.07	2.32	14.29	2.08
Total	-	-	476.60	100	686.5	100
Predators plants					Average No./ 10	
Coleoptera						
Coccinellidae	*Scymnus* spp.	L,A	27.14	34.08	38.0	41.59
	Coccinella undecimpunctata L.	L,A	22.86	28.70	32.29	35.34
Staphylinidae	*Paederus alfierii* (koch)	A	2.21	2.77	1.5	1.64
Homoptera						
Anthocoridae	*Orius* sp.	N	2.57	3.23	2.36	2.58
Neuroptera						
Chrysopidae	*Chrysoperla carnea* Steph.	E,L,A	12.50	15.70	7.21	7.90
Diptera						
Syrphidae	Syrphidae	L, A	2.43	3.05	2.79	3.05
Araneae	Spiders	S, A	9.93	12.47	7.21	7.90
Total	-	-	79.64	100	91.36	100

E = Egg, L=larva, N= nymph, A=adult, M= mobile stage, S= Spiderling

El-Sheikh and El–Nagar (1994) stated that, the prevalent species of aphids were *Myzus persicae, Aphis gossypii* and *Macrosiphum euphorbiae. M. persicae* occurred in March/May. *M. euphorbiae* and *A. gossypii* occurred in mid April on potato in the summer plantation at Giza governorate. Abd El-Fattah *et al.* (2000), reported that infestation of potato plants by *M. persicae*, *A. gossypii* and *Macrosiphum pisi* was much higher in summer plantation than in Nili plantation at El-Badrshein, Giza governorate. El-Khawas and Shoeb (2004) found that the percentages of predatory species occurrence in the two seasons together were as follows; *C. carnea*

(20.25%), *(Scymnus* spp*. & C. undecimpunctata* (13.92%), *Orius* sp. (7.60%)*, P. alfierii* (6.33%)*, Syrphus* sp. (6.33%) and spiders (21.52%) at Qalubia governorate. Musa *et al.* (2006) found that the survey of *M. persicae*, for potato significant differences in aphid build up and distribution were observed with regard to the surveyed localities, years of survey and their interaction. Abbas *et al*. (2015) indicated that *M. persicae* remained a regular pest with different densities throughout the growing season.

2. Population fluctuations of *Phthorimaea operculella* larvae on potato plants:

Population densities of *P. operculella* larvae on potato plants at Kafr El-Sheikh and Al-Gharbiya governorates, 2014 season are shown in (Fig.1). At Kafr El-Sheikh, the highest population densities of larvae were recorded on April 27th and May 4 th &18 th. At Al-Gharbiya, the highest population densities of larvae were recorded on March 30 th, April 27 th and May 4 th &18 th (Fig. 1).

3. Efficiency of compounds on *Phthorimaea operculella* larvae:

The effect of the tested compounds on *P. operculella* infesting potato plants at Kafr El-Sheikh and Al-Gharbiya governorates are presented in Tables (2&3). At Kafr El-Sheikh Table (2) Dipel 2 x and Match were the most potent compounds in reducing the population density of potato tuber moth larvae, with reductions of 86.31 and 81.96 % respectively. It was followed by Proclaim, Malathate, Deltarab and Penny, while Protecto showed a low effect in 2014 season after two sprays (Table 2).

At Al-Gharbiya, Table (3) Proclaim and Dipel 2 x were the most potent compounds in reducing the population density of potato tuber worm moth larvae, recording 82.48 and 79.93 % reduction respectively. It was followed by Deltarab, Match, Penny and Malathate, while Protecto showed a low effect in 2014 season after two sprays.

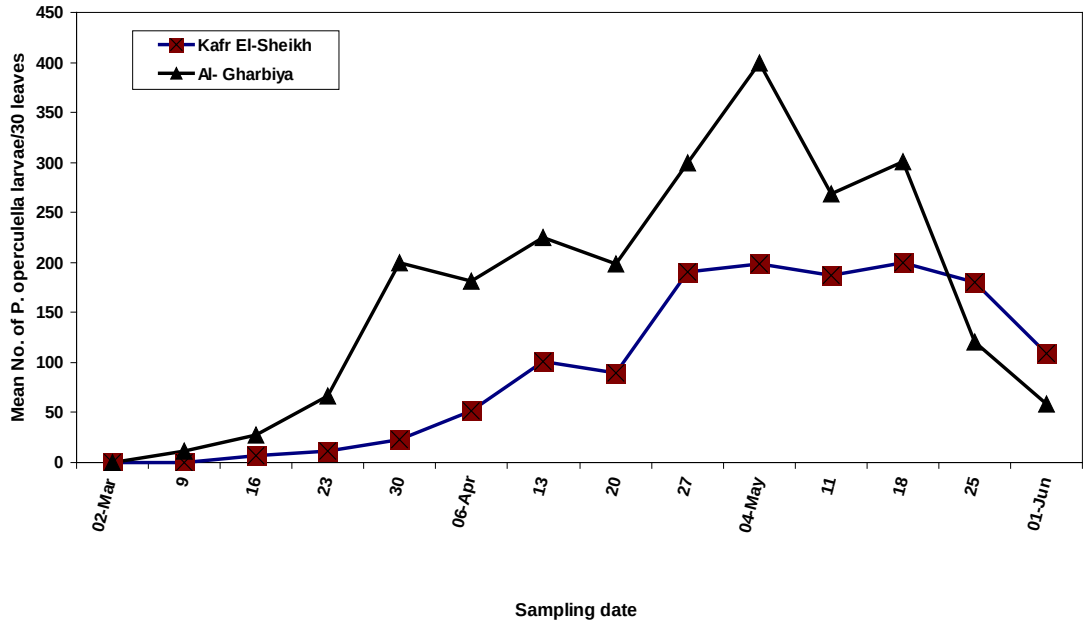

Fig. (1): Population fluctuations of *Phthorimaea operculella* larvae on potato plants in season 2014.

Table (2): Potency of tested compounds in reducing *Phthorimaea operculella* larvae on potato at Kafr El-Sheikh Governorate in 2014 season.

Compound	Rate/100 liter of water	1st spray		2nd spray		Average reduction %
		No. pre treat. /40 plant	% Reduction after 10 days	No. pre treat. 40 plant	% Reduction After 10 days	
Malathate	1000 ml	97.0	81.83	17.0	74.01	77.92
Match	80 ml	94.0	81.25	17.0	82.67	81.96
Penny	100 ml	79.0	79.00	16.0	72.39	75.70
Deltarab	26 ml	96.0	81.64	17.0	74.01	77.83
Proclaim	30g	106.0	76.52	24.0	81.59	79.06
Dipel 2 x	100g	84.0	83.95	13.0	88.67	86.31
protecto	100 g	76.0	56.34	32.0	76.99	66.67
Untreated	-	84.0	-	81.0	-	-

Table (3): Potency of tested compounds in reducing *Phthorimaea operculella* larvae on potato at Al-Gharbiya Governorate in 2014 season.

Compound	Rate/ 100 liter of water	1st spray		2nd spray		Average reduction %
		No. pre treat /40 plant	% Reduction after 10 days	No. pre treat. /40 plant	% Reduction after 10 days	
Malathate	1000 ml	76.0	76.45	16.0	75.00	75.73
Match	80 ml	85.0	73.68	20.0	83.33	78.51
Penny	100 ml	81.0	73.76	19.0	82.46	78.11
Deltarab	26 ml	93.0	84.36	13.0	74.36	79.36
Proclaim	30 g	73.0	83.14	11.0	81.82	82.48
Dipel 2 x	100 g	81.0	76.52	16.0	83.33	79.93
protecto	100 g	80.0	65.04	25.0	73.33	69.19
Untreated	-	132.0	-	118.0	-	-

Das *et al.* (1992) found that Agreen was inafective against *P. operculella.* In field study with potato (Abdel-Mageed *et al.,* 1998) found that abamectin was the most effective against *P. operculella* followed by profenofos and *Bacillus thuringiensis*. Humaida (2007) resulted that Spinosad, *B. thuriengiensis* and NeemAzal gave 100%, 82.8% and 74.1% mortality on the third instar larvae of *P. operculella,* while the three compounds gave 100% mortality on the second instar. Dobie (2010) found that methamidophos, indoxacarb, and esfenvalerate were predicted to cause 95-100% mortality of *P. operculella* for about five days after application. Spinetoram associated mortality was predicted to decline to about 80%. Abdel-Razek *et al.* (2014) found that Nimbecidine treatments after 3 applications reduced the larval mine of potato tuber moth by 79.6 and 43.8% when applied at 5.0 and 2.5 ml/l, respectively while Bio-power treatments reduced the larval mine of PTM by 56.7 and

30.85%, respectively after the same applications.

4. Effect of tested compounds in chlorophyll content (SPAD) on potato leaves:

Data presented in Table (4) showed that chlorophyll content significant differences due to compound applications. The chlorophyll content grand average increased significantly by Dipel 2x treatment, while it was the least with Proclaim treatment on leaves potato. The other tested compounds had moderate effects after two sprays at Kafr El-Sheikh.

At Al-Gharbiya, (Table, 4) chlorophyll content in SPAD had the highest with Protecto and Match treatments, while it was the least with Proclaim treatment on leaves potato. The other tested compounds had moderate effects on chlorophyll content after two sprays.

Seth *et al.* (2014) found that the increase in total chlorophyll content due to Neem extract treatment was significantly the same as synthetic pesticide (dimethoate) treated plant.

5. Effect of Dipel 2x and protecto to control the PTM on potato tubers in stores:

The *Bacillus thuringiensis* (Bt) treatments recorded average reductions of 54.51 and 60.22% for Dipel 2x while, protecto was 62.28 and 73.02% for tuber infestations potato production in 2014 season at Kafr El-Sheikh and Al-Gharbiya governorates respectively (Table, 5). Dipel 2x recorded average reductions of 71.60& and 75.19% while, protecto was 77.61 and 80.12% for tuber infestations potato production in 2015 season at Kafr El-Sheikh and Al-Gharbiya Governorates respectively (Table, 6).

Table (4): Effect of tested compounds in chlorophyll content in potato leaves at Kafr El-Sheikh and Al-Gharbiya Governorates.

Compound	Rate/100 liter of water	Chlorophyll content (SPAD) unit					
		Kafr El-Sheikh			Al-Gharbiya		
		1st spray	2nd spray	Average	1st spray	2nd spray	Average
Malathate	1000 ml	45.10	39.73	42.42^{f}	45.67	44.13	44.90^{f}
Match	80 ml	44.97	42.47	٤٣.٧٢^{e}	48.70	45.73	47.22^{b}
Penny	100 ml	46.27	41.47	٤٣.٨٧^{d}	48.50	43.03	45.77^{e}
Deltarab	26 ml	48.90	39.40	٤٤.١٥^{c}	35.93	48.60	٤٢.٢٧^{g}
Proclaim	30 g	41.43	38.37	٣٩.٩٠^{h}	41.00	43.00	42.00^{h}
Dipel 2 x	100 g	45.80	44.93	٤٥.٣٧^{b}	43.00	49.80	46.40^{c}
protecto	100 g	45.57	38.17	٤١.٨٧^{g}	52.43	44.23	48.33^{a}
Untreated	-	52.17	46.00	49.09^{a}	47.73	46.33	٤٦.٣٣^{d}
LSD $_{05}$				1.26			2.19

Table (5): Effect of Dipel 2x and protecto on *Phthorimaea operculella* infestations /100 tubers in 2014 season.

Treatment	Rate/ton	No. pre treat. of tuber infestations	After 15 days		After 30 days		Average reduction%
			No.	Reduction %	No.	Reduction %	
Kafr El-Sheikh							
Dipel 2 x	150 g	7.00	8.00	51.88	15.00	57.14	54.51
Protecto	150 g	9.00	9.00	57.898	14.00	66.67	62.28
Untreated	-	8.00	19.0	-	40.00	-	-
Al-Gharbiya							
Dipel 2 x	150 g	13.00	13.0	47.06	10.00	73.37	60.22
Protecto	150 g	12.00	7.00	69.12	8.00	76.92	73.02
Untreated	-	9.00	17.0	-	26.00	-	-

Table (6): Effect of Dipel 2x and protecto on *Phthorimaea operculella* infestations /100 tubers in 2015 season.

Treatment	Rate/ton	No. pre treat. of tuber infestations	After 15 days		After 30 days		Average reduction %
			No.	Reduction%	No.	Reduction %	
Kafr El-Sheikh							
Dipel 2 x	150 g	28.00	11.00	69.55	10.00	73.64	71.60
Protecto	150 g	22.00	7.00	75.34	6.00	79.87	77.61
Untreated	-	31.00	40.00	-	42.00	-	-
Al-Gharbiya							
Dipel 2 x	150 g	21.00	9.00	71.43	7.00	78.95	75.19
Protecto	150 g	18.00	6.00	77.78	5.00	82.46	80.12
Untreated	-	36.00	54.00	-	57.00	-	-

Das *et al.* (1992) found that 0.2% Bactospeine, *Bacillus thuringiensis* was ineffective for up to 2 and 4 months against PTM of storage. Under the storage condition, Abdel-Mageed *et al.* (1998) found that abamectin was the most effective followed by fenitrothion and *B. thuringiensis* on tuber infestations *P. operculella*. Gomaa

(2007) found that Dipel 2x and protecto gave satisfactory results against tuber infestations *P. operculell*a. Mandour *et al.* (2012) found that Neemix, Virotecto, Agerin, Dipel 2x and Spinosad were recorded in terms of reduction rate of *P. operculella* pupae and mines in tubers. Thakur and Chandla (2013) found that in the storage, *Bacillus thuringiensis* and Neemexcel afforded complete protection to potato tubers from *P. opercullela* up to 15 days of treatment and were significantly superior even after 45 days of the treatment with an average tuber infestation ranging from 1.33-16.67% as compared to 89.33% in the control.

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الكثافة العددية لفراشة درنات البطاطس فى العروة الصيفية المبكرة و كذلك تأثير بعض المركبات السامة عليها فى الحقل و المخزن وعلى محتوي الكلورفيل فى الاوراق

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الملخص العربى

أجري البحث فى منطقة شنو بمحافظة كفرالشيخ و منطقة العتوة بمحافظة الغربية عام ٢٠١٤. يهدف البحث إلى حصر الآفات و المفترسات المتواجدة على زراعات البطاطس صنف ديامونت فى المنطقتين وأيضا الكثافة العددية لفراشة درنات البطاطس فى العروة الصيفية المبكرة و كذلك تأثير بعض المركبات السامة عليها فى الحقل والمخزن و أيضا على محتوي الكلورفيل فى الاوراق .

أوضحت نتائج الحصر وجود ١٢ نوعاً من الآفات تنتمى إلى تسعة عائلات والتى تتبع ستة رتب تم تسجيلها على البطاطس فى الحقل فى المنطقتين و كان أكثرها تعدادا المن و يليها فراشة درنات البطاطس و أقلها البقة الخضراء. وأيضا تم تسجيل سبع أنواع من المفترسات تنتمى إلى ستة عائلات والتى تتبع خمسة رتب على نباتات البطاطس و كان الاسكمنس هو الأكثر تواجدا و أقلها الحشرة الرواغة. وكانت الكثافة العددية ليرقات فراشة درنات البطاطس فى زراعات الغربية أعلى منها فى زراعات كفرالشيخ. سجلت يرقات فراشة درنات البطاطس أعلى تعداد لها فى إبريل و مايو فى كفرالشيخ بنيما كانت فى مارس و إبريل و مايو فى الغربية.

كذلك تم دراسة تأثير بعض المركبات الكيماوية على يرقات فراشة درنات البطاطس فى زراعات البطاطس. و قد أظهرت النتائج أن كل المركبات المختبرة حقليا أدت إلى خفض تعداد الآفة على نباتات البطاطس مع تفاوت نسب الخفض فى الإصابة،حيث كان دايبل×٢ وماتش أكثر المركبات سمية ضد يرقات الآفة و تلا ذلك بروكليم و ملاثيت و دلتا راب و بنيى فى كفرالشيخ بعد رشتين .بينما بروكليم و دايبل×٢ أكثر المركبات سمية ضد يرقات الآفة و تلا ذلك بروكليم ودلتا راب وماتش و بنيى و ملاثيت فى الغربية. بينما كان بروتكتو ذو سمية منخفضة على يرقات الآفة فى المنطقتين. كما أوضحت النتائج أيضا أن رش المركبات المختبرة صاحبه وجود اختلافات معنوية فى محتوى الكلورفيل فى اوراق البطاطس. فقد زاد محتوى الكلورفيل زيادة معنوية مع معاملة دايبل×٢ فى منطقة كفرالشيخ بينما ظهر هذا مع بروتكتو وماتش فى منطقة الغربية فى حين كان بروكليم أقلها.و قد أعطى المركبين البكتريين دايبل×٢ و بروتكتو تأثير جيد على خفض الإصابة بفراشة درنات البطاطس فى المخزن.

كلمات مفتاحية: الآفات، المفترسات، فراشة درنات البطاطس، زراعات البطاطس،المركبات، التخزين، الكلورفيل.

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