Yield Losses of Potato Tubers due to Infestation with *Gryllotalpa gryllotalpa* (Gryllotalpidae: Orthoptera) and *Penitodon bispinosus* (Scarabaeidae: Coleopteran) Based on Insecticide Treatment at Nubaria Region, Egypt

Emad, M. El- Adawy[1], Osman, A. Zaghloul[2], Ahmed, M. Kordy[2], Mohamed, M.El-Shazly[2] and Magda,M. Khtab [3]

ABSTRACT

The present investigation has been conducted in the two successive summer seasons of 2014 followed by the winter one of 2015, for the purpose of appraising yield losses to potato tubers caused by the two key subterranean insect pests: *Gryllotalpa gryllotalpa*(L), *Penitodon bispinosus* Kust

Potato plants were treated with two recommended doses of seven insecticidal baits at 70 and 85 days from sowing. These poisonous baits were Fipronil, Chloropyrifos methyl, Fentrothion, Dimethoate, Azadirachtin, *Bacillus thuringiensis* and *Beauveria bassiana*.

In the summer season of 2014, the obtained data revealed that loss percentages were 7.86, 9.13, 11.62, 12.5, 25, 25.01, 25.63 and 50 for tubers treated with Fipronil, Chloropyrifos methyl, Fentrothion, Dimethoate, Azadirachtin, *B.T*, *B. bassiana* and control, respectively.

Correspondingly 2015 as a winter season for the crop, these percentages were 3.76, 6.24, 12.5, 12.51, 25, 28.12 and 40.62% for the control successively.

It is worth mentioning, that loss percentages are considered as a prerequisite step for the determination of seven economic injury levels for each insect pest. The computed economic injury levels (EILs) values pertaining to *G. gryllotalpa* were 0.1, 0.11, .011, 0.31, 0.10, .014, 0.17, insect/100 tubers as a result of using Fipronil, Chloropyrifos methyl, Fentrothion, Dimethoate, *Azadirachtin*, *B.T* and *P. bispinosus*, respectively. Whereas in case of the *B. coriacea*, the economic injury levels (EILs) values were 0.41, 0.65, 1.44, 0.64, 1.81, 0.52 and 1.23 insect /100 tubers were also due to the application of the same poisonous baits, respectively, for *P. bispinosus*, *G. gryllotalpa* plantation of 2014.

In the season 2015, the EILs values due to infestation by *G. gryllotalba* were 0.54, 0.25, 0.18, 1.43, 0.36, 2.8 and 0.25 insects/100 tubers for Fipronil, Chloropyrifos methyl, Fentrothion, Dimethoate, Azadirachtin, *B.T* and *Beauveria bassiana* baits, in respect. Corrispondingly, EILs the *P. bispinosus* were 0.1, 0.1, 0.1, 3.8, 0.41, 0.22 and 0.31 insect/100 potato tubers for the some applied baits, in respect.

Keywords: Potato soil insect - Insecticidal control-Yield loss assessment - Economic injury levels.

INTRODUCTION

The importance of yield losses assessments caused by pest infestation on crops has been studied some reasons for making such assessments are the establishment of the economic status of specific pests (Golebiowska and Romankov, 1968); to find the infestation that justifies control (chiarappa *et al*, 1970) and to give a basis for directing future research and agriculture planning and forecasting (Walker, 1967 and Al-Eryan and El-Tabbakh, 2004).

Some authors have used replicated field trials to assess crop losses a result of pest infestation, using randomized blocks or on randomly selected plots in fields. In their experiments, they have kept some plots free from pests by blanket insecticide treatments or other control measures whereas the plants of the other plots are allowed to be damaged by naturally occurring populations of the same pests.

Other authors have assessed yield losses under natural field conditions either by regression analysis (Gage and Mukerji, 1978) by the analytical method (Judinko, (1973) and Al-Eryan, 2004). The analytical method is based on the comparison of yields of infested and un infested plants with specific pest which are growing under identical conditions.

From the point of view, it could be concluded that as early as in (Weiss and Dickerson 1918) mentioned that the European mole cricket *Gryllotalpa gryllotalpa* (or: Orthoptera, Fam: Gryllotalpidae) (L.1958) is an important insect pest in field crops in Iran. Rolston and Barlow (1980) recorded the larvae of the white grub, *phyllophaga ephilida* (Say) on sweet potato. Several investigators referred to *Gryllotalpa gryllotalpa* and *P. bispinosus*.(Hope) (Or: Coleoptera as serious insect pests on potato tubers in Iran ,India and Egypt. Several investigators refered to *G. gryllotalpa* and *P. bispinosus* as serious insect pests on potato tubers in Iran, India and Egypt [Veenakumari and Veeresh (1982) ,Singh (1989) ,Kakate *et al* (1991), Bahgat (2001); (2003), Chandel *et al*. (2005), Chandla and Chandel (2007); Zaki (2007); Puja Rani *et al* (2009), Anupam Sharma *et al* (2012),

[1] Plant Protection Institute, Agric. Res. Center, Nubaria Station,Egypt.
[2] Plant Protection Dept., Faculty of Agric. (Saba Basha), Alexandria Univ.
[3] Plant Protection Institute, Agric. Res. Center, Egypt.
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Walker (1937), Sanaa, Abdel Kader (2000) and Mohammad Munib *et al*. (2016)].

As a matter of fact, information on *P. bispinosus* seems to be very scarce. Howevers Misra and Sharma (1987); Chandel (1992) and Mehta *et al* (2010), mentioned that certain insect pests may causes yield losses ranging 41.2 to 98.3 quintals/ha due to infestation with several species of white grabs. This investigation aims at adding some knowledge on the Economic injury levels (EILs) of two key subterranean insect pests on the assessment of potato tuber loss at EL-Noubaria region, Beheira Governorate Egypt.

Stern *et al*., (1959) defined EIL as: "the lowest population density of a pest that will cause economic damage; or the amount of pest injury, which will justify the cost of control." The present study aimed at the following two objectives: a- to assess potato tuber loses due to the combined infestation with *Gryllotalpa gryllotalpa* (L) and *P. bispinosus*. (Hope). And b- approximate (EILs) for both considered potato insect pests using different insecticide baits.

MATERIALS AND METHODS

1- Experimental site and design:

The present field investigations aimed at determining the efficacy of seven insecticide baits on the moving stages of both ***G. gryllotalba*** (nymph & adults) and ***P. bispinosus*** (larvae and adult)**.** As both pests were as major importance in potato fields in the experimental site the two potato growing seasons in summer 2014 and winter 2015 at the Research Farm of Agrofood Company, 60 km, southwest Alexandria city, El-Noubaria, district, El-Behiera Governorate of Egypt. Arandomized completed block desingn replicated three times was used block.

In both seasons an area of 620 m was divided into three longitudinal blocks(replicates). Each block was then sub divided into eight (8) plots. The area of each plot measured 25m^2 and contained (6) rows of 5m long × 0.90 cm wide ×30 cm. height followed to there now measurement were intiont conally prevent, as much as possible the damage caused be the potato tubers moth *Phthorimaea Operculella*(Zeller), that infests usually plant canopy (Ministry of Agriculture)

The experimental area was cultivated with the potato cv. "Vallor"., *Solanum tuberosum* L. *(Solanaceae)* on the 15 th of December,2014 as a summer plantation potatoes were sown on 25 th of September, as a winter plantation. Potato tubers "grade A" were imported from Scotland. They were sown in each plot at a distance of 20 cm, I e. each plot included 126 hills. Buffer area of 1m wide was left between blocks. Every two adjacent plots to avoid any interference or contamination of the insecticidal treatments.

All agriculture practices were adopted according to the recommendations of the Egyptian Ministry of Agriculture. Furthermore, N and K fertilization of the experiments all area were standardized to suit the sandy soil.

2- Insecticidal treatments.

Seven insecticides were used to induce different levels of infestation with the two considered insect pests treatment was left untreated to serve as control. Insecticidal treatments were applied as baits. Insecticidal treatments were randomly distributed in the experimental area in a RCBD. To prepare required baits, the amount each of the 7-insecticide used were thoroughly mixed with 1kg Allum (potassium sulphate) +15 kg. ground corn kernels+ 1kg molas + 20 L. of water. Before insecticidal treatment, plots were first irrigated in the morning, and the baits were evenly spread in the evening between the 2 rows 8 plants ⁄ plot. Baits were applied twice once when the plants aged 75 days and again when their age reached 85 days.

3- Insecticides:

The trade and common names of the 7 tested insecticides used in field experiments together with their formulation and application rates are shown in Table (1).

4- Yield loss assessment

All recommened agriculture practices were strictly applied to minimize as much as possible the expected damage coused by *ph opercullella*. *G. gryllotalba* and ***P. bispinosus*** and the percentage of yield losses. At harvest, the tuber weight per plot were recorded as evidence of yield components. Appraisal of potato tubers loss percentages due to infestation with both was calculated according to the following that modified from the formula described by Zahid *et al*., (2008):

% loss percent = $[(Y_{op} – Y_{t2...5} / Y_{op}) \times 100]$,

Where: -

Y_{op} = optimal yield.

$Y_{t2... 5}$ = yield for each insecticidal treatment.

5- Determination of economic injury levels (EIL).

The equation used for the determination of insecticidal treatments on potato tuber yield were based on the study of

Following steps in order:

1- Recording yield loss due to potato tuber injury then working out the better- fit equation to find out a regression coefficient.

Table 1. Trade names, commen names, formulation and dose of tested insecticides

Group	Trade name	Common name	Formulation	Application rate
Phenylpyrazoles (Fiproles)	Coach®	Fipronil	SC	1 litre /fed.
	Houky®	Chloropyrifos methyl	EC	250 cm/fed.
Organophosphates	Sumithion K® Z®EEEEEEEEEC	Fenitrothion	EC	1 litre / fed.
	Perfecthion40%®	Dimethoate *thuringiensis*	EC	5oo gm/ fed.
Bio- insecticide	Nimbecidine®	Azadirachtin	EC	1 litre / fed.
	Protecto®	*Bacillus thuringiensis*	WP	1 litre / fed.
	Careprotector®	*Beauveria bassiana*	WP	2kg/ fed.

2- Determining the economic injury level by adopting the following equations below:

a- $$\text{Gain threshold (G T)} = \frac{\text{Control costs (C C)}}{\text{Price of one metric ton of potato}} \qquad (1)$$

and

b- $$\text{EIL} = \frac{\text{GT}}{\text{Regression Coefficient}} \qquad (2)$$

Stone and Pedigo (1972). As described by in that respect, linear equations were obtained for each considered insect pest, for every tested.

6- Statistical analyses:

To compare effect of the different tested insecticidal bait treatments on EIL determination, the regression lines._Data were subjected to analysis of variance (ANOVA) using "F" test and the least significant differences (L.S.D) at$\leq$ 0.05 level according to the computer program (COSTAT software,1988) and steel and Torrie (1981)

RESULTS AND DISCUSSION

Yield loss assessment

According to (khosla, 1976). it is worth mentioning that crop loss implies quantitative as well as qualiatitative reduction in yield. Earlier studies before the seventiense of century depended on the so called "guess mates" reported by many researchers and administrators in India. These guess mates were based on the following: (Pradhan,1964). Stated that 1-The absence of adequate data collected on sufficiently large scale of the key insect pest population dynamics, 2-The lack of information regarding the relationship between insect injury and its host; in the sense, paucity of knowledge about the impact of the insect pest damage on the physiological processes of the host plant and, 3-The non-availability of information about the sound standardized techniques in appraising crop loss. Therefore, crop loss estimations in the past were in it is infest stage

(Zaghloul,1982). Added that in appraising crop loss, two important points are generally considered: The first point to be taken into account in that losses caused by insect pests vary in time and space from (0- 100 depending on a large number of environmental and other biotic factors which tend to invalidate any assessment. The second point to be kept in view is the economic consideration in terms of money returns and profits to farmers, which is always variable.

1- 2014 Experiment:

A- Quantitative loss assessment in potato tubers of the season of 2014:

the effect of insecticidal treatments on the quantitative loss assessment in potato tuber in 2014 summer plantation**.**

In shown in Table (2), it has been noticed that the bio insecticides were less efficient than the other used chemical baits. This table refers that infested with the mean number of infested 100 potato tubers *G. gryllotalba* (adults and nymphs) were 3.33, 3.67, 3.33, 4.33. 3.67,7.67, 5.33 and 9.33 after treatment with Fipronil, Chloropyrifos methyl, Fentrothion, Dimethoate, Azadirachtin, *Bacillus thuringiensis*, *B. bassiana* and control, respectively. Correspondingly the mean number of tubers infested with by *B. coriacea* /100 tubers were 3.33, 4.00, 4.67, 3.00, 6.33, 10.00, 6.00, and 3.33 (beetles and larvae for treatments with the same abovementioned insecticide baits, respectively. Yield loss % could be arranged descending by as follows: 50.00, 25.62, 25.00, 13.90, 12.48, 9.14 and 7.87 for control, *B.bassiana*, Azadirachtin and *B.T*, Fentrothion, Dimethoate, Chloropyrifos methyl and Fipronil.

Yields of potato tubers, represented an important factor in expressing the efficacy of the used insecticidal baits against *G. gryllotalba* and *P. bispinosus.* Comparison on basic yield /ton/fed, it indicated that

Fipronil, was superior and yielded (19.350 ton/fed). followed by Chloropyrifos methyl (19.080 ton), Fentrothion (18.560 ton), Dimethoate (18.380 ton), both Azadirachtin, *B.T* and *B.bassiana* (15.620 ton), whereas the control yielded (10.500) ton/ fed., successively, during summer 2014 season.

Results refer that all tested chemical baits gave higher potato tuber productivity ranging from to than the bio chemicals that yielded tuber productivety of 19.350 to 15.620 ton / Fed. This means that the chemical compounds were relatively more efficient in combating the studies insect pests than that the biochemical baits.

Cumulative yield loss for *G. gryllotalba* and *P. bispinosus* due to both insect pests were 7.86, 9.13, 11.62, 12.5, 25, 25.01, 25.63, and 50, successively, for the 7 tested insecticidal baits and the control.

Results referred that insecticidal treatments with Fipronil, Chloropyrifos methyl, Fentrothion, Dimethoate, Azadirachtin, *B.T* and *B. bassiana* led to subsequent low increases in the mean yield of potato, which have significant differences between them and the controls.

From the statistical point of view, it was obvious that Fipronil, Chloropyrifos methyl, Fentrothion and Dimethoate were in increasing production; with no statistical differences. among them. However poisonous baits could divided into the following three categories according to efficiency:

a- Fipronil, Chloropyrifos methyl, Fentrothion and Dimethoate, which proved to be the most efficient chemicals in killing the tow effeiciency against key pests under study.

b- Azadirachtin , *B.T* and *B. bassiana* occupied a second rank in insect potato crop yield with, no significant differences between them.

c- Control were the least treatment in producing potato tubers.

Similarly, quantitative losses in potato tubers followed the same above category.

B- Quantitative loss assessment in potato tubers:

The percentage of calculated commulative losses were 7.86, 9.13, 11.62, 12.5, 25, 25.01, 25.63, and 50% for Fipronil, Chloropyrifos methyl, Fentrothion, Dimethoate, Azadirachtin, *Bacillus thuringiensis* and *Beauveria bassian,a* respectively.

C- Quantitative loss assessment in potato tubers.

The effect of insecticidal treatments on the quantitative loss assessment in potato tuber in 2015 winter plantation:

The mean number of infested potato /100 potato tubers damage by *G. gryllotalba* (adults and nymphs)/100 tubers were 3.00, 2.33, 0.67, 2.00, 3,7.33, 3.33 and 7,67 after treatments with Fipronil, Chloropyrifos methyl, Fentrothion, Dimethoate, Azadirachtin, *B.T*, *B. bassiana* and control ,respectively. Corresponding the means for infestation *P. bispinosus* /100 tubers were 7.00, 7.67, 3.00, 5.00, 10.67, 15.33, 11.67, and 20.67(beetles and larvae), respectively (Table 3). Perecentage of yield loss percents could be arranged in a descending order as follows: 40.62 ,25.00. 28.12, 28.12, 20.12, 12.51, 12.5, 6.24, and 3.76 for the control , Azadirachtin, , *Beauveria bassiana*, *B.T*, Fentrothion, Fipronil, Chloropyrifos methyl, Dimethoate. Produced yields of potato tubers could be considered an important factor in expressing the efficacy of the used insecticidal baits against *G. gryllotalba* and *P. bispinosus.* Comparison on baits of the means yield of potato tubers mean yield in tons / fed. Insecticide that Dimethoate, was the superior to the other tested bait treatments. With mean of 13.470 tons / fed., ton/fed. followed by Chloropyrifos methyl (13.130), both Fipronil and Fentrothion (12.250 tons / fed.), Azadirachtin (10.500 tons / fed.), both *B.T*, *B. bassiana* (10.060 tons / fed.) whereas the control yielded 8.310 ton/ fed., subsequently.

It was evident that the chemical baits resulted in higher productivity than the bio baits where Dimethoate and Chloropyrifos methyl recorded of 13.470 and 13.13 12.250 ton / Fed. respectively. This means that the chemical compounds were more successful than that of the bio baits in combating the studied insect pest.

Percentage of yield loss due to damage caused by both insect pests were 12.5, 6.24, 12.51, 3.76, 25, 28.12, 28.12 and 40.62 % , in respect, for the tested insecticidal baits as well as the control, due to infestation with *G. gryllotalba* and *P. bispinosus* (Table 3).

Results referred that insecticidal treatments with Fipronil, Fentrothion, Azadirachtin, *B.T* and *B. bassiana* led to less increases in the mean yield of potato with significant difference between them and the controls.

From the statistical point of view, it was obvious that Dimethoate, Chloropyrifos methyl, Fentrothion and Fipronil were in increasing production; with no statistical differences. among them. However poisonous baits could have divided into the following three categories according to efficiency:

a- Dimethoate, Chloropyrifos methyl, Fentrothion and Fipronil, which proved to be the most efficient chemicals in killing the tow efficiency against key pests under study.

b- Azadirachtin, *B.T* and *B. bassiana* occupied a second rank in insect potato crop yield with, no significant differences between them.

c- Control were the least treatment in producing potato tubers.

As a discussion, it was evident also that both *G. gryllotalba* and *P. bispinosus* were on par in producing potato yields as well as commulative losses in potato tubers.

It was first thought that losses due to the assigned insect- pests in the summer season of 2014 would be higher than that of the winter plantation; but surprisingly the obtained results in the winter season witnessed higher losses in tubers than that of the summer one. This controversy, could be interpreted due to the long duration of both insects as well as their roaming behavior, that enable them to produce more damage to the potato crop. Additionally, the mole cricket nymphs and adults can't tolerate the relative higher temperature(Sanaa, 2002) and Munibe *et al* (2016), while making somewhat superficial tunnels just under the soil surface, especially in the sandy soil. This phenomenon is based on the current observations of the author.

Tables (2,3) indicated that furthermore, tested insecticidal baits insecticides acted differently between *G. gryllotalba* and, *P. bispinosus*. In this regard, it was clear that *G. gryllotalba* was the most susceptible to the tested insecticides rather than *P. bispinosus*. The obtained results indicated that the white grubs damaged and /or infested more potato tubers than that in case of mole cricket (Tables, 2, 3).

(Misra 1995) stated that *B.coriacea* was the predominant species in the north-western hills of Himachal Pradesh, India. It is damage to potato tubers ranged from 15.5 to 80.0% (based on the weight of total damaged potatoes) in prone areas.

B. Determination of multiple economic injury levels (EILs) of both *G. gryllotalba*, *B. coriacea* insect pests.

Table 2. Efficiency of the recommended doses of the used insecticide baits on both potato yields and cumulative loss percentages of tubers by *Gryllotalba.gryllotalbaon* and *P. bispinosus* in the summer season of 2014

Insecticidal bait	Mean no.of infested tubers/100tubers by both insect pests		Yield (Ton/fed.)	comulative losses %
	*G.gryllotalba*on	*P. bispinosus*		
Fipronil	3.33^{b}	3.33^{d}	19.350^{a}	7.86
Chloropyrifos methyl	3.67^{b}	4^{cd}	19.08^{a}	9.13
Fentrothion	3.33^{b}	4.67^{bcd}	18.56^{a}	11.62
Dimethoate	4.33^{b}	3^{d}	18.38^{a}	12.5
Azadirachtin	3.67^{b}	6.33^{b}	15.75^{b}	25
Bacillus thuringiensis	7.67^{a}	10^{a}	15.75^{b}	25.01
Beauveria bassiana	5.33^{b}	6^{bc}	15.62^{b}	25.63
Control	9.33^{a}	3.33^{d}	10.50^{c}	50
L.S.D 0.05	1.99	2.15	1.59	

Means followed with the same letter (s) are not significantly different from each other at P= 0.05.

Table 3. Efficiency of the tested chemical –insecticides on the rates of infested Potato tubers by *G.gryllotalba*on and *P. bispinosus* and collective yield losses in potato crop in the winter season of 2015

Insecticidal bait	Mean no. of infested tubers/100tubers by both insect pests		Yield (Ton/fed.)	Collective losses %
	*G.gryllotalba*on	*P. bispinosus*		
Fipronil	3^{b}	7de	12.25^{b}	12.5
Chloropyrifos methyl	2.33^{b}	7.67^{d}	13.13^{ab}	6.24
Fentrothion	0.67^{c}	3^{f}	12.25^{b}	12.51
Dimethoate	2^{bc}	5^{ef}	13.47^{a}	3.76
Azadirachtin	3^{b}	10.67^{c}	10.5^{c}	25.00
Bacillus thuringiensis	7.33^{a}	15.33^{b}	10.06^{c}	28.12
Beauveria bassiana	3.33^{b}	11.67^{c}	10.06^{c}	28.12
Control	7.67^{a}	20.67^{a}	8.31^{d}	40.62
L.S.D $_{0.05}$	1.55	2.45	1.05	-

Means followed with the same letter (s) are not significantly different at P= 0.05.

1. Summer plantation of 2014

Assessment of crop loss is a prerequisite step for the determination of the economic injury level. In this respect, the parameter of % mean loss against the mean number of infested tubers for each insect pest was essential to get the EILs values. The total control costs including insecticides price + labour wages that differed for the different used insecticides being L.E 1710, 1500,1520,1520.1540.1560 and 1620 for the Fipronil, chloropyrifos methyl, fenitrothion, Dimethoate, Azadirachtin, *B.T* and *B. bassiana*, respectively (Table 4).

In regressing lines of Tables 4 losses (kg) of potato tubers against the mean number of infested tubers by *G. gryllotalpa*:

The effect of insecticidal treatments on the quantitative loss the assessment in potato tuber in 2014 summer plantation.

Similarly, the EIL values for. the white grub, *P. bispinosus* were 0.41, 0.65, 1.44, 0.64,1.81,0.52 and 1.23 for Fipronil, Chloropyrifos methyl, Fentrothion, Dimethoate, Azadirachtin, *B.T* and *B. bassiana*, successively.

Winter plantation of 2015

The effect of insecticidal treatments on the quantitative loss assessment in potato tuber in 2015 Winter plantation**.**

Table 4. Summer of the lines regressing formula values for each considered insect pest receining different insecticidal baits for the summer plantation of 2014

Group	Insecticidal bait	*G. gryllotalba*	*P. bispinosus*	*G. gryllotalba*	*P. bispinosus*
Phenylpyrazoles	Fipronil	Y= 8.7012X -9.2029	R^2 = 0.8193	Y= - 1.442X + 10.792	R^2= 0.5377
Organophosphates	Chloropyrifos methyl	Y= 5.3126X - 4.9207	R^2 = 0.6869	Y= 1.1286X + 9.8867	R^2 = 0.3658
Organophosphates	Fenitrothion	Y= 6.5856X - 7.5732	R^2 = 0.7656	Y= - 0.5229X + 8.94	R^2 = 0.1519
Organophosphates	Dimethoate	Y= 2.4288X + 5.8412	R^2 = 0.1209	Y= - 1.178X + 10.75	R^2 = 0.4176
Bio insecticide	Azadirachtin	Y= 7.2665X + 2.7927	R^2 = 0.6841	Y= 0.4157X + 7.9163	R^2 = 0.1238
Bio insecticide	*Bacillus thuringiensis*	Y= 5.4566X + 1.4622	R^2 = 0.7759	Y= 1.4746X + 4.7107	R^2 = 0.3936
Bio insecticide	*Beauveria bassiana*	Y= 4.7696X + 1.1428	R^2 = 0.5998	Y= 0.6486X + 7.1433	R^2 = 0.1614

Table 5. Winter of the lines regressing formula values for each considered insect pest receiving different insecticidal baits for the summer plantation of 2015

Group	Insecticideal bait	Y		R	
		G. gryllotalba	*P. bispinosus*	*G. gryllotalba*	*P. bispinosus*
Phenylpyrazoles	Fipronil	Y= 1.2517X 11.746	R^2 = 0.2998	Y= 4.4774X + 3.5207	R^2= 0.5095
Organophosphates	Chloropyrifos methyl	Y= 2.3317X – 1.716	R^2 = 0.6299	Y= -5.6483X + 36.751	R^2 = 0.5088
Organophosphates	Fenitrothion	Y= 3.304X - 2.698	R^2 = 0.9181	Y= 6.443X + 40.851	R^2 = 0.8078
Organophosphates	Dimethoate	Y= 0.4203X + 3.3061	R^2 = 0.0159	Y= - 0.1576X + 12.177	R^2 = 0.0003
Bio insecticide	Azadirachtin	Y= 7.2665X + 2.7927	R^2 = 0.6841	Y= -1.481X + 29.393	R^2 = 0.1893
Bio insecticide	*Bacillus thuringiensis*	Y= - 0.2177X + 10.789	R^2 = 0.0553	Y= 2.7843X + 14.597	R^2 = 0.6464
Bio insecticide	*Beauveria bassiana*	Y= 2.5825X + 0.5475	R^2 = 0.9104	Y= -2.082X + 33.085	R^2 = 0.3935

Table 6. Economic injury levels (EILs) the mole cricket,*G. gryllotalba* and White grubs *P. bispinosus* in 2014 winter plantation

Insecticidal baits	Yield (Ton/fed.)	Total control Cost in L.E.	EILs *G.gryllotalba*	EILs *P. bispinosus*
Fipronil	12.25^{b}	1710	0.54	0.1
Chloropyrifos methyl	13.13^{ab}	1500	0.25	0.1
Fentrothion	12.25^{b}	1520	0.18	0.1
Dimethoate	13.47^{a}	1520	1.43	3.8
Azadirachtin	10.5c	1540	0.36	0.41
Bacillus thuringiensis	10.06^{c}	1560	2.8	0.22
Beauveria bassiana	10.06^{c}	1620	0.25	0.31
Control	8.31^{d}	-	-	-
L.S.D $_{0.05}$	1.05	-	-	-

Table 7. Economic injury levels (EILs) the mole cricket, *G. gryllotalba* and White grubs *P. bispinosus* in 2014 summer plantation

Insecticidal baits	Yield (Tons /fed.)	Total control Cost in L.E.	EILs *G.gryllotalba*	EILs *P. bispinosus*
Fipronil	19.350[a]	1710	0.1	0.41
Chloropyrifos methyl	19.080[a]	1500	0.11	0.65
Fentrothion	18.560[a]	1520	0.11	1.44
Dimethoate	18.380[a]	1520	0.31	0.64
Azadirachtin	15.750[b]	1540	0.10	1.81
B.T	15.750[b]	1560	0.14	0.52
Beauveria bassiana	15.620[b]	1620	0.17	1.23
Control	10.500[c]	-	-	-
L.S.D $_{0.05}$	1.05	-	-	-

Regression equations for *G. gryllotalpa* resulted in the EILs values of 0.54, 0.25, 0.18, 1.43, 0.36, 2.8 and 0.25 (adults and nymphs) for Fipronil, Chloropyrifos methyl, Fentrothion, Dimethoate, Azadirachtin, *B.T* and *B. bassiana.* respectively. For the White grubs *B.coriacea* regression equations indicated EILs values: of 0.1, 0.1, 0.1, 3.8, 0.41, 0.22 and 0.31 for the same insecticidal baits, respectively. Similarly, regressing losses against potato tubers number of infested by *G. gryllotalpa* seven formulas were explained and obtained as follows:

It is worth mentioning, that these EILs values for the is subterranean insect pests are not permanent or constant values, but thus may differ according locality, product price, and insecticide cost. In other words, the EIL is a dynamic value.

Perusing precisely the data included in Tables (6&7), it has been noticed that the EILs values varied among the applied insecticides. Such variations might be due to the interaction between chemicals and potato plants, which surely affect the physiological processes and pathways of plants as well as the insect pests.

The computed low EIL values in this study validated the recommended schedule of the used insecticide baits twice throughout the season as recommended by the Egyptian ministry of Agriculture management organizers.

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الملخص العربي

خسائر محصول البطاطس الناجمة عن الإصابة وبالحفار والجعل ذو الظهر الجامد بناء علي المعاملة بالمبيدات في منطقة –النوبارية مصر

عماد مصطفى العدوى، عثمان أحمد زغلول، أحمد محمد كردى، محمد محروس الشاذلى، ماجدة محمد خطاب

اجريت هذة الدراسة خلال موسمى ٢٠١٤ – ٢٠١٥ على درنات البطاطس من اجل تقييم الخسائر الناتجة عن كل من حشرة الحفار *Gryllotalpa gryllotalpa* (L) وحشرة الجعال *Brahmins coriacea*.(Hope) حيث تم معاملة الدرنات بسبعة طعوم من المبيدات الحشرية وفقا للجرعات الموصي بها وذلك في عمر ٧٠ و٨٥ يوم من الزراعة وكانت المبيدات المستخدمة في تجهيز الطعوم هي الفيبرونيل ، الكلوروبيروفوس ميثيل، فينتروثيون، ديمثويت، الازادرختين، الباسيلس ثورينجنسين ثم البيوفاريا بوسيان. حيث اظهرت النتائج المتحصل عليها خلال موسم الصيف ٢٠١٤ ان نسبة الخسائر في درنات البطاطس كانت ٧,٨٦، ٩,١٣، ١١,٦٢، ١٢,٥، ٢٥، ٢٥,٠١، ٢٥,٦٣ ثم ٥٠% لكل من الفيبرونيل، الكلوروبيروفوس ميثيل، فينتروثيون، ديمثويت، الازادرختين، الباسيلس ثورينجنسين، البيوفاريا بوسيانا ثم الكنترول على التوالى. اما خلال الموسم الشتوي لعام ٢٠١٥ كانت نسبة الخسائر ٣,٧٦، ٦,٢٤، ١٢,٥، ١٢,٥١، ٢٥،٢٨,١٢ ثم ٤٠,٦٢% لكل من الفيبرونيل، الكلوروبيروفوس ميثيل، فينتروثيون، ديمثويت، الازادرختين، الباسيلس ثورينجنسين، البيوفاريا بوسيانا ثم الكنترول على التوالى.

ومن الجدير بالذكر أن نسب الخسارة تعتبر خطوة أساسية لتحديد سبعة مستويات إصابة اقتصادية لكل آفة حشرية. حيث كانت قيمة مستوى الضرر الاقتصادي (EIL_S) خلال موسم ٢٠١٤ لحشرة الحفار *Gryllotalpa gryllotalpa* (L) ٠,١، ٠,١١، ٠,٠١١، ٠,٣١، ٠,١٠، ٠,٠١٤، ثم ٠,١٧ حشرة/ ١٠٠ درنة الفيبرونيل، الكلوروبيروفوس ميثيل، فينتروثيون، ديمثويت، الازادرختين، الباسيلس ثورينجنسين، البيوفاريا بوسيانا ثم الكنترول على التوالى، اما بالنسبة لمستوي الضرر الاقتصادي لحشرة *Brahmins coriacea*.(Hope) كانت ٠,٤١ ، ٠,٦٥ ، ١,٤٤ ، ٠,٦٤،٠,٥٢،١,٨١ ثم ١,٢٣ حشرة / ١٠٠ لكل من مبيد الفيبرونيل، الكلوروبيروفوس ميثيل، فينتروثيون، ديمثويت، الازادرختين، الباسيلس ثورينجنسين، البيوفاريا بوسيانا ثم الكنترول على التوالى

في حين اظهرت النتائج خلال موسم ٢٠١٥ لحشرة الحفار *Gryllotalpa*: *gryllotalpa* (L) ان مستوى الضرر الاقتصادى ٠,٥٤، ٠,٢٥، ٠,١٨، ١,٤٣ ، ٠,٣٦، ٢,٨ ثم ٠,٢٥ حشرة / ١٠٠ درنة لكل من مبيد الفيبرونيل، الكلوروبيروفوس ميثيل، فينتروثيون، ديمثويت، الازادرختين، الباسيلس ثورينجنسين، البيوفاريا بوسيانا ثم الكنترول على التوالى .في حين كان مستوى الضرر الاقتصادى لحشرة الجعال *Brahmins coriacea*.(Hope) ٠,١، ٠,١، ٣,٨، ٠,٤١، ٠,٢٢ ثم ٠,٣١ حشره/ ١٠٠درنة لكل من مبيد الفيبرونيل، الكلوروبيروفوس ميثيل، فينتروثيون، ديمثويت، الازادرختين، الباسيلس ثورينجنسين، البيوفاريا بوسيانا ثم الكنترول على التوالى.