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CONTROL OF POTATO TUBER MOTH *PHTHORIMAEA OPERCULELLA* (LEPIDOPTERA: GELECHIIDAE) BY IMIDACLOPRID

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Abstract

Potatoes infested by *Phthorimaea operculella* (Lepidoptera: Gelechiidae) which is a harmful insect causes a destructive to many economic crops in all over the world. Imidacloprid LC50s, 156 and 65 ppm on *P. operculella*. The eggs laid / female decreased by 77.6% in case of nano imidacloprid treatments and decreased by 4.7% in imidacloprid only. Field experiments proved that, when the pathogen and nano pathogen increase the weight of potatoes tubers by 1.3% and 1.4% in season 2018 after nano imidacloprid spraying and increased by 1.2% and 1.3% in plots sprayed by imidacloprid in seasons 2018 and 2019 respectively. Nano pathogen tested gave a higher decrease in *operculella* infestations numbers under laboratory and field conditions.

Key words: Imidacloprid, *Phthorimaea*, control, nano.

Introduction

Potato tuber moth *Phthorimaea operculella* PTM attack potatoes an many other economically crops. The adults of female moths put eggs inside the tubers eyes. When larvae hatched, thy feed on the tubers through tunnels, larvae coms out for pupation git rid their black residues and block the tunnels. These cause a plant diseases on the leaves and shoots and decrease the crop quality and destroy the tubers. *Phthorimaea operculella* controlled by the insecticides which pollute the surrounding and diseased the human with a malignant diseases.

Chemical insecticides causing insects to adopt and resist them, which leads to a highly outbreaks the pests (Lowery and Sears, 1981).

Imidacloprid pathogen stress to keep in soil, water, air or all environment, the elevation of the photodegradation trend and they accumulate in the soil and soluble in water.

Mode of action of this pathogen is blocking the nervous system through the neuronal tubes. Second, imidacloprid block neurons by accumulation of acetylcholine inside it which prevent neurotransmitter materials to pass in the end insects come paralyzed then died.

Imidacloprid inter the insect body by mouth and stomach action or by contact.

The nucleotide imidacloprid attach very strongly with the receptors of the pests neurons.

In agriculture applications and inset control, imidacloprid used by spraying trees, foliars, or whole crops, sometimes it applied in the soil.

The use of the Nanotechnology field is a promising relating to more than one branch of knowledge in field research. The uses of nanotechnology beneficially in agriculture applications. These great support of nanotechnology include insect control due to nanomaterials formulations especially pesticide. The traditional planning used in field of agriculture by usage of the insecticides have dangerous effects on human and livestock beside decreasing the fertility of the soil (Sparks *et al*., 2012). The nanotechnology playing important roll in alternatives for the controlling serious agriculture pests without harming the environment. (Ragaei and Sabry, 2014) made a review article described haw to control pests by nano pesticides methods.

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Sabbour, (2017) found that, in Egypt the leopard moth, reduced numbers when imidacloprid applied on olive trees. The usage of nano entomopathogenic *Nomuraea rilleyi* or *Isaria fumosorosea* and spinosad in olive field, decrease the numbers of infestation of olive insects, as well as the same results occur in the laboratory conditions Sabbour, (3013 a,b).

Therefore, the present work targets to determine Imidacloprid and nano-Imidacloprid efficacy on *P. operculella*.

Materials and Methods

Rearing Insects

Larvae of potato tuber moth reared in a Standard laboratory colony on small tubers of potatoes. Pupae collected till moths emergence, then put every male and female in glass jar 15×20 cm covered by muslin paper. put a tissue paper in the tope of the jar for egg laying. Eggs collected and kept in Petri dish 10×10 cm till the newly larvae hatched.

Laboratory experiments

Six concentrations were prepared of the insecticides Imidacloprid starting of 2.000 to 0.125 ppm by half dilutions. Tubers of potatoes were dipped the concentration prepared for ten seconds. Then twenty newly hatched larvae introduced the newly potato tuber moth on treated potatoes. Control (non-treated) experiments made by feeding the newly hatched larvae by clean tubers (sprayed by water only). Experiments replicated four times. Mortality calculated after 7 days, the corrected mortality calculated due to Abbott's formula (Abbott, 1925) and the corrected mortality calculated according to (Finney, 1971) to determine the LC_{50} value.

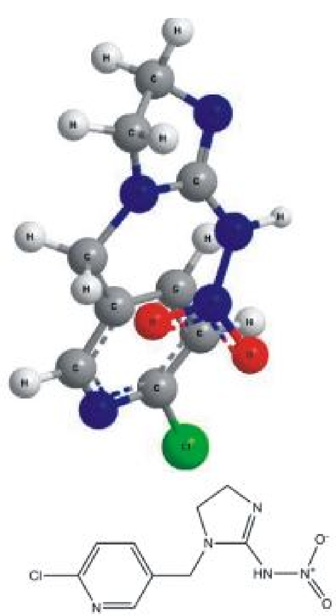

Fig. 1: Chemially Imidaclopride consists of. 1-(6-chloro-3-pyridylmethyl)-N-nitroimidazolidin-2-ylideneamine.

Field experiments

The field experiments were executed, at Menia El-Kamh (Sharkia) during 2018 and 2019, the experiment starting in summer potato planting at 1st July till 31st August. 1500 m^2 divided into 15 areas each $100m^2$, five areas for imidacloprid, five for nano-imidacloprid and five for untreated (Control). Imidacloprid applied at 0.15 ppm, nano imidacloprid applied at 0.22 ppm, control sprayed by water only. Six potato tubers and leaves were collected randomly each weeks from each treatment areas. The infestations average numbers calculated every period 20, 90 and 120 days. In the harvest time the potatoes weighted for each treatments.

Statistical analysis

The software SPSS program were used for all statistical calculations.

Results and Discussion

LC50s of imidacloprid and nano Imidacloprid 156 and 65 ppm of *P. operculella* shown in table 1.

The effect of imidacloprid and Nano- Imidacloprid on potato tuber moth biology showmen in table 2, the eggs number/female significantly decreased to 49±1.8 and 3±2.7 comparing to control 233 ± 34.2 eggs /female. The percentages of egg hatching significantly decreased to 2% as compared to 100% in the control. The percentage of larval, pupal and adult mortality significantly decreased after imidacloprid and nano Imidacloprid as compared to the control.

Laboratory experiments showed that, the egg hatchability were highly affected in the nano and Nano-Imidacloprid treatments areas. Also, the eggs hatchability showed a significantly decreased.

The eggs hatchability percent reached to 14 and 1% in imidacloprid and Nano- Imidacloprid comparing to 99% in the control areas. Pupae and adults recorded a significant malformations (Table 3).

Field experiments conducted into Menia El-Kamh (Sharkia). In season 2018 the potatoes tubers weight

Table 1: Effect of Imidacloprid and nano- Imidacloprid on *P. operculella*.

Pathogens	LC50	S	Confidence limits
Imidacloprid	156	0.2	186-121
Nano Imidacloprid	65	0.3	85-41

Table 2: Effect of Imidacloprid and nano Imidacloprid on *P. operculella*.

Tested materials	Eggs numbers Per female	Eggs hatchability %	% Mortality of larvae	% Mortality of pupal	% Mortality of adult
Imidacloprid	49±1.8	12	14	11	12
Nano- Imidacloprid	3±2. 7	2	1	1	1
Control	233 ± 34.2	100	99	98	98
F value Lsd 5%	17.911.0	15.92.3	23.03.9	22.84.3	37.03.9

Table 3: potatoes tuber weight after pathogen treatments in the field.

Tested materials	Potatoes weight by tons 2018	Potatoes weight by tons 2019
Imidacloprid	12. 92±75.13	13.82±85.11
Nano- Imidacloprid	13.79±44.28	14.99±64.21
Control	10.07±53.41	10.00± 40.59
F value Lsd 5%	42.423.1	37.922.2

increased to 12. 92±75.13 and 13.79±44.28 tone/ feddan in areas treated with imidacloprid and Nano- Imidacloprid comparing to control area which recorded 10.07±53.41 tone/feddan.

During the tested season 2019, In corresponding treated area weight of potatoes reached to13.82±85.11 and 14.99±64.21 tons/ Fadden as compared to and 10.00±40.59 tons/ feddans in the control, during seasons 2018 and 2019, respectively (Table 3).

Economic return from treatment of potato crop with Imidacloprid, Nano-Imidacloprid. Table 4 shows that the treatment of potato crops using Imidacloprid, Nano-Imidacloprid contributed to an increase in the productivity of feddan to reach about 13.37 tons, 13.39 tons, with percentage increase of about 3.33%, 3.35%, compared to the productivity of feddan for control which reached about 10.04 ton. The table also shows a decrease in the cost of producing a ton of the crop by about 24.9%, 25%, while the net ton yield increased by 170.5%, 171.1%, which results in an increase in the return of the invested pound by about 0.38 pounds for the two transactions mentioned previously, respectively, when compared to the results of the control.

Table 5 shows that the added value resulting from the treatment of potato crops using Imidacloprid, Nano-Imidacloprid, where feddan need about 100 grams of both materials and their cost is about 1500 pounds, 1800 pounds for each, respectively. This increase in the cost of feddan production contributes to an increase in the productivity of an feddan by about 3.33 tons, 3.35 tons, as well as an increase in total feddan revenue by about 8921.07 pounds, 8974.65 pounds and the total cost of tons reached about 450.450 pounds, 537.313 pounds and the total revenue per ton reached about 2697 pounds and thus the return on The pound invested for a transaction is about 5,943 pound, 4,986 pound, compared to the return of the pound invested to produce tons in the case of control, which amounts to 1.146 pounds. The state's plan aims to produce about 150 thousand tons during this year to provide about 1.4 billion pounds of import costs for potato seeds (Country plan 2030) and this can be achieved through the treatment of about 12 thousand feddans, representing about 2.94% of the total potato area and amounting to About 408 thousand feddans using Imidacloprid, Nano-Imidacloprid, As the seeds of potatoes, which are imported from abroad, are seeds of the seventh generation, they are loaded with diseases and use certain methods of cultivation and control, While Egyptian seeds will be produced from the third generation and are disease-free, with high quality specifications and give higher productivity than imported, Which benefits the farmer and the consumer of the local market, as the cost of seeds represents about 40% of the total production costs and when provided locally, the cost of feddan production will decrease and the feddan yield will increase, along with the decrease in the prices of the local Egyptian market and the elimination of monopoly and greed of traders.

Table 4: Effect of using Imidacloprid and Nano-Imidacloprid on potato crops.

Treatments	Average productivity of the two seasons ton / feddan	% Increase in productivity per feddan	The amount of increase per ton / feddan	The cost of producing tons / pound	Return ton / pound	Net return per ton / pound	Return on the invested pound
Imidacloprid	13.37	33.17	3.33	1755.23	2679	923.77	1.526
Nano- Imidacloprid	13.39	33.37	3.35	1752.65	2679	926.35	1.529
control	10.04	-	-	2337.45	2679	341.55	1.146

Source: Calculated and compiled from table 3, Ministry of Agriculture and Land Reclamation - Secondary Bulletin of Agricultural Statistics 2018-2019

Table 5: The added value from the treatment of potato crops using Imidacloprid, Nano-Imidacloprid.

Treatments	The increase in production ton / feddan	The increase in the cost of feddan /pounds	The increase in revenue /pounds	Cost per ton / pound	Return per ton / pound	Return on the invested pound / the transaction	The cost cultivated area / thousand feddans
Imidacloprid	3.33	1500	8921.07	450.450	2679	5.943	408
Nano- Imidacloprid	3.35	1800	8974.65	537.313	2679	4.986	408
control	-	-	-	-	-	-	-

Source: Calculated and compiled from table 3, Ministry of Agriculture and Land Reclamation - Secondary Bulletin of Agricultural Statistics 2018-2019

Discussions

In order to explain effectiveness of the imidacloprid and nano imidacloprid on *P. operculella*, the nano imidacloprid decrease the LC50 of the imidacloprid 3 times. Many authors examined the imidacloprid and the nano imidacloprid on many insects (Sabbour, 2015; Sabbour and Singer 2015) who proved that, insects decreased in its number after imidacloprid. The results were in close conformity with Sabbour and Abd El-Raheem, (2016) and Sabbour and Nayera, (2016) who, said that imidacloprid causing insect paralysis and leas to death of the pests. The effect of the tested materials on larval period decreased by using the imidacloprid Sabbour, (2015), supported our results on eggs the insecticide causes a decreasing in eggs hatching during the experiments. The malformed pupa observed during the experiments, the results were disagree with the findings of Lawrens, (2009) who reported that the imidacloprid have unacceptable effect against the *P. operculella* in tobacco and tomatoes fields. Foot, (1974), reported that the bioinsecticides and insecticides have an obvious systemic effect as those occur and appear with the insecticidal properties when they appear and applied to plant and soil and their effect on the leaf treatment is not enough.

The results clearly indicate that the imidacloprid and nano imidacloprid compounds an evident which showed a high biological effectiveness on *P. operculella* under laboratory and field conditions and successfully applied in the field of tomatoes. Kau, (2006) reported that Acetamiprid and imidacloprid have a weak or average effect on larval stages. Sabbour, (2015a) stated that the olive pests controlled by Imidacloprid,also nano imidacloprid proved a significant effect in the olive field.

Sabbour, (2015b) affirmed that the high infestation rate by *P. operculella*, *significantly decreased* in potato plants after fungi applications. Sabbour, (2013) noticed that Spinosad decreasing the olive pests in the laboratory and decrease the trees pest infestans in the field.

(Karunaratne *et al*., 2012; Khot *et al*., 2013) expressed that the nanopesticides achieved an perfect and excellent results when applied on the harmful insects.

(Cox *et al*., 1997, 1998), stated that, low dosages of biopesticides have a lower rats and higher absorption and sorption in field. (Cox *et al*., 1998) stated that imidacloprid highly absorbed and increased tits persistence in the soil after the application with manure fertilizers, chicken fertilizers. (Guan *et al.*, 2008, 2010) reported that, soyabean sprayed leaves by nano imidacloprid formulation this stop the ingathering of the pathogen on the leaves and in the soil which causing lead to premier, effectiveness the pathogen.

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