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TOXICITY OF IMIDACLOPRID ON CABBAGE WHITE BUTTERFLY *(PIERIS RAPAE).*

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Abstract

Cabbage crop attack by the harmful pests *Pieris rapae* (Lepidoptera: Pieridae) *w*hich causing a lot of damage to devour cabbage crop varieties. Imidacloprid is a perfect bioinsecticide. The usage of Imidacloprid and nano Imidacloprid test against *Pieris rapae* gave a promising data. Results showed that, the LC50 obtained 133 and 31 ppm after *Pieris rapae* treated with different concentrations of Imidacloprid and nano Imidacloprid. Also, under field conditions when *S. oleae* treated with the Imidacloprid and nano Imidacloprid, the number of eggs significantly 55±6.1 and 5±7.2 eggs/ female as compared to 289±6.9 eggs /female in the control. The percentage of egg hatching, larval mortality, malformed pupae and malformed adults significantly decreased in case of Imidacloprid treatments and almost reduced after nano Imidacloprid treatments. The weight of cabbages fruits significantly increased to 2566 ± 43.01 and 1210± 40.09 kg/ feddan as compared to 1780±55.43 and 1200±33.11 kg/ feddan in the control during season 2018 and 2019 respectively.

Key words: Nano, Imidacloprid, *Pieris rapae*, control.

Introduction

Cabbage white butterfly, *Pieris rapae* important insect found in the eastern Mediterranean part and the north region of Africa. It infects many economic crops as cabbages family, causing loss of the crop plant. The female of *P. rapae* put their eggs on cabbage family leaves Sahab and Sabbour, (2005). The eggs hatch after one to three weeks, then the larvae eat their egg shell and beginning to eat the plant leaves gluttonous. the eggs mass have a greenish brown colour.

Larvae of *P. rapae* causing a lot of damage to the plant including, a holes in different size and irregular in the leaves. Larvae also causing a leaves ragged due to their feeding on the leaf edges (Fullaway and Krauss, 1945). The larvae excrement may be found in the crevices observed in the gaps parts of the plant. Larvae Extensive feeding causing a destructive and loss of the plant growth.

The cabbage worm controlled by chemical insecticide which considered a harmful materials pollute the surrounding (Lowery and Sears, 1981). Recently, it must be found a new research studies for controlling this pests. Imidacloprid directly affect on insect nervous system. Imidacloprid has the following structure found in the fig. 1.

Imidacloprid help to reduce many pests in the field and other crops (Sabbour and Sahab, 2007). The aim of the present study to evaluate some imidacloprid and nano imidacloprid on the cabbage moth.

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Materials and Methods

Tested Insects

Cabbage white butterfly, *Pieris rapae*. Reared under laboratory conditions according to Susan E. Webb and Anthony M. Shelton, (1988).

Preparation of Imidacloprid

Commercial Imidacloprid obtained from Amazon.com. It prepared by National Research Centre microbiological team due to Sabbour, (2015) methods. To test the effects of Imidacloprid on *P. rapae*, two types of bioassays, tests according to Sabbour, (2018) and Ritieni *et al*., 1997).

Table 1: Effect of Imidacloprid and nano- Imidacloprid on *Pieris rapae*.

Pathogens	LC50	S	Confidence limits
Imidacloprid	132	0.2	156-120
Nano Imidacloprid	32	0.1	45-21

Field experiments

The experiments were conducted in El-Fayoum during 2018 and 2019 season.

The experiments were started at the first of May until the end of July in order to evaluate the efficacy of the tested pathogen on *P. rapae* under field conditions. Five rows the cabbage sprayed by imidacloprid at the rate of 145 ppm and five experiments sprayed by water only as control part. A five rows of cabbage sprayed by nano-imidacloprid at the rate of 55ppm. A five random cabbages collected from treated and control experiment, each week and transferred to the NRC laboratories for examination, till the end of the experiments. All treatments sprayed by 10 litre sprayer.

The Percentage of *P. rapae* infestation/cabbage sample was calculated after 20, 50, 90 and 120 days of the application. The infestation of, *P. rapae* were calculated in each experiment case. In the harvest time, cabbage collected and the yield of each experiment treatment were weighted as Kg/Feddan.

Results and Discussions

The effect of imidacloprid and nano imidacloprid explained in (Table 1), which show that, the LC50 of *P. rapae* treated with Imidacloprid is 132 ppm and LC50 of nano Imidacloprid is 32 ppm after *Pieris rapae*.

Imidacloprid and nano Imidacloprid, the number of eggs significantly 49±1.8 and 3±2.7 eggs/ female as compared to 233 ± 34.2 eggs /female in the control. The percentage of egg hatching, larval mortality, malformed pupae and malformed adults significantly (Table 2).

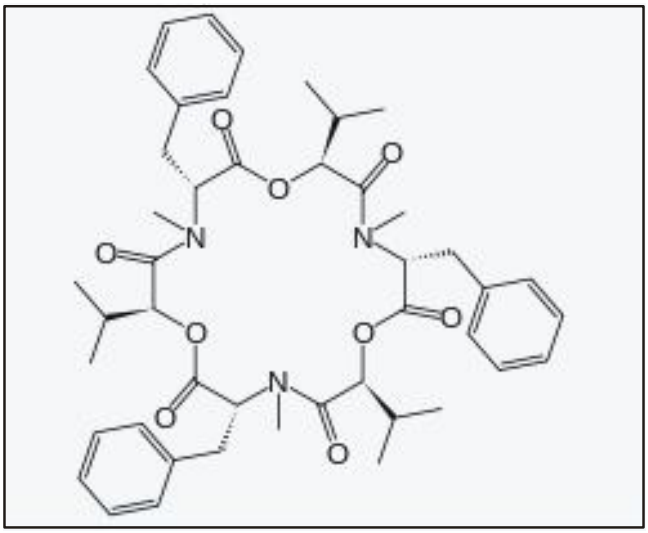

Fig. 1: The structure of imidacloprid.

Under field conditions experiments data showmen that, *Pieris rapae* treated with Imidacloprid and nano Imidacloprid, significantly decreased in numbers of eggs to 49±1.8 and 3±2.7 eggs/ female as compared to 233 ± 34.2 eggs /female in the control. The percentage of egg hatching, larval mortality, malformed pupae and malformed adults significantly decreased in case of Imidacloprid treatments and almost reduced after nano Imidacloprid treatments (Table 2). The weight of potatoes significantly increased to 2392±75.13 and 2779±44.28 kg/ feddan as compared to 177±53.41 and 1210±40.59 kg/ feddan in the control during season 2018 and 2019 respectively (Table 3).

Table 2: Effect of Imidacloprid and nano Imidacloprid on *Pieris rapae* tested biology.

Treatments	No of eggs laid/female	% of egg hatching	% of larval mortality	% of pupal mortality	% of adult mortality
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%					

Table 3: Assessments of damage caused after treatment with the pathogens in cabbage field.

Treatments	Season 2018 Wt of cabbage (Ton/ feddan)	Season 2019 Wt of cabbage (Ton/ feddan)
Imidacloprid	2392±75.13	2582±85.11
Nano- Imidacloprid	2779±44.28	2989±64.21
Control	177±53.41	1210±40.59
F value Lsd 5%		

The economic return of resistance the white butterfly insect on Egyptian cabbage crop.

The study of economic returns requires the definition of both productive and economic efficiency, while productive efficiency expresses the production of the largest number of production units using the lowest amount of resources available, while economic efficiency expresses the production of goods at the lowest possible production cost. The economic return study was based on a study of each of the costs of agricultural operations during the two seasons of production, the return of the invested

Table 4: The relative importance of the different cost items.

The operation	Season 2018		Season 2019	
	Production costs	%	Production costs	%
Labor wages	2720	28.26	3484	30.25
Machinery	1081	11.23	1371	11.90
Seeds cost	465	4.83	522	4.53
Manure	587	6.10	917	7.96
Fertilizers	809	8.41	965	8.38
Insecticides	241	2.51	317	2.75
Other expenses	531	5.51	664	5.76
Rent	3190	33.15	3279	28.47
Total production costs	9624	100	11519	100
Production quantity/ Tons	16.6		12.10	
Price per ton/ pound	1250		1259	
Total revenue	20750		15233.9	
Net return	11126		3714.9	
Return on invested pound	2.156		1.323	

Source: calculated and collected from a table 3, Ministry of Agriculture and Land Reclamation - Annual Bulletin of Agricultural Statistics 2016, 2019.

pound and the added value of white butterfly insect resistance. (*Nayera Y. Solieman, Rania M. Barghash, 2016*).

The costs, revenues and returns of the invested pound per feddan of cabbage crops during the two production seasons

Table 4 shows that the total costs of feddan production reached about 9624 pounds and about 11519 pounds in each of the two production seasons for the years 2018 and 2019. The costs of rent, labor and automated services represent about 72.64% of the total production costs during 2018, while the costs of labor, rent and automated services represent about 70.62% of the total production costs during 2019. The table also shows that each of the total amount produced, the total revenue and the return of the invested pound per feddan reached about 16.6 tons, 12.1 tons and about 20,050 pounds, 2,1533.9 pounds, 2,156 pounds, 1,323 pounds during the two production seasons 2018 and 2019, respectively.

The most important indicators of the economic efficiency of the white butterfly insect resistance of the Egyptian cabbage crop

Table 5 shows the most important economic efficiency indicators that are represented in the cost per ton, the ton yield, the net ton yield and the invested return pound in each of the two production seasons. As it was found that the resistance of the white butterfly insect by using both Imidacloprid and Nano-Imidacloprid resulted in a decrease in the costs of producing a ton by about 30.6%, 40.27% and an increase in each of the net tonn yield by about 26.51%, 34.87% and the yield of the invested pound per ton by 44.11%, 67.39% for the agricultural season 2018, as a result of the decrease in the costs of producing tons by about 53.14%, 59.52% and increasing each of the net revenue of tons by 164.75%, 217.12% and the invested return pound by 113.3%, 146.94%, compared to Control. *(Nayera Y. Solieman, Mohamed Gamal Mady Abu-Azaim and Y. Hamouda, 2015).*

The added value of white butterfly insect resistance on Egyptian cabbage crop

The resistance of the white butterfly insect to the Egyptian cabbage feddan using Imidacloprid and Non-Imidacloprid resulted in an increase in feddan production costs by about 1500 pounds, 1,800 pounds respectively in each of the two production seasons as shown in table 6. It also resulted in an increase in each of the production amount by about 7.32 tons, 11.19 tons and total feddan revenue by about 9,150 pounds, 13987.5 pounds and the return of the invested pound reached 6.1 pounds, 7.770 pounds each, respectively for the first season 2018. As for the agricultural season 2019, the amount of production increased by about 13.72 tons, 17.79 tons and total feddan revenue by about 17273.49 pounds, 22397.61 pounds and the invested return pound reached about 10.516 pounds, 11.443 pounds each, respectively. *(Nayera Y. Solieman, Rania M. Barghash and Abou-hussein, S.D., 2015).*

Based on the above, the most important results of

Table 5: Economic efficiency indicators.

The indicator	Season 2018			Season 2019		
	Control	Imidacloprid	Nano- Imidacloprid	Control	Imidacloprid	Nano- Imidacloprid
Cost per ton	579.759	402.341	346.312	951.983	446.127	385.380
Return/ ton	1250	1250	1250	1259	1259	1259
Net return per ton	670.043	847.659	903.688	307.017	812.837	973.62
Return on invested pound	2.156	3.107	3.609	1.323	2.822	3.267

Source: calculated and collected from table 3 and 4.

Table 6: The added value.

The indicator		midacloprid	Nano-Imidacloprid	midacloprid	Nano-Imidacloprid
The cost of resistance per feddan	Pound	1500	1800	1500	1800
The increase in the production of feddan	Tons	7.32	11.19	13.72	17.79
Price per ton	Pound	1250	1250	1259	1259
Total revenue	Pound	9150	13987.5	17273.49	22397.61
Net return	Pound	7650	12187.5	15773.49	20597.61
Return on invested pound	Pound	6.1	7.770	10.516	11.443
Source: calculated and collected from table 3 and 4.					

the study can be listed as follows:

The resistance of the white butterfly insect infesting the Egyptian cabbage using Non-Imidacloprid resulted in a decrease in the costs of producing a ton, increasing both the tonnage yield and the invested pound return in both production seasons compared to the control or the using of Imidacloprid. In the case of generalizing the resistance of the white insect using Non-Imidacloprid to the total cultivated area of the Egyptian cabbage crop, which reached about 23 thousand feddans, the total produced amount of about 325 thousand tons will be 79%, or by about 125% if the productivity increase per feddan is about 11.19 tons, or 17.79 tons, as in the 2018 and 2019 agricultural season, respectively, as this increase in the amount of production contributes to increasing the volume of supply in the Egyptian local markets and thus the stability or decrease in the price of the commodity and controlling the monopoly of traders. Finally, the study recommends the necessity of the country was built for the method of white insect resistance to cabbage using Non-Imidacloprid and generalization among farmers at the Republic level through the agricultural guide, which his role and activity has shrunk in recent years.

The Previous research results also showed by Sabbour and Nayera, (2018), Sabbour and Nayera, (2019). Other research results indicted that higher concentration of product associated with a higher mortality is of the pests independent of the stage of maturity Sabbour, (2017), Sabbour and shourab, (2017 and 2018). The results were in accordance with the findings of Sabbour, (2018,a,b; 2019). Also, (Milner, 2002). (Castillo *et al*., 2000) who strongly confirmed that the imidacloprid control and reduce insects. Sabbour and Shourab, (2018) supplemented the present findings by control pests by imidacloprid. Pedras *et al*., (2002). Noticed that imidacloprid application decrease the insect in numbers. Hu *et al*., 2006 and 2007, Loranzo-Tovar *et al*., 2012) affirmed that the high morality of insects obtained after imidacloprid application. Amiri *et al*., 1999 confirmed that destruxin cause higher mortality.

References

Castillo, M., P. Moya, E. Herna´ndez and E. Yufera (2002). Susceptibility of *Ceratitis capitata* Wiedemann (Diptera Tephritidae to entomopathogenic fungi and their extracts Biol. *Control.,* **19:** 274-282.

Fullaway, D.T. and N.L.H. Krauss (1945). *Pieris rapae* (L.). 139-139. In: Common Insects of Hawaii. Tongg Publishing Company, Honolulu, Hawaii. 228 pages.

Hu, Q., S. Ren, A.n. S. and M.Q. Jan (2007). Insecticidal activity influence of Destruxin on the pathogenicity of *Paecilomyces javanicus* against *Spodoptera littoralis*. *J. Appl. Entomol*., **131:** 262-268.

Hu, Q., S. Ren, J. Wu and J. Chang Musa (2006). Investigation of Destruxin A and B from 80 *Metarhizium* strains in China and the optimization of cultural conditions for the strain MaQ10. *Toxicon*., **48:** 491-498.

Lozano-Tovar, M.D., I. Garrido-Jurado and E. Quesada-Moraga (2012). Potential of secondary metabolites secreted by the entomopathogenic mitosporic ascomycetes *Beauveria* sp. and *Metarhizium* spp. for medfly *Ceratitis capitata* adult control. In International citrus congress. Valencia, Spain.

Milner, R.J., P.R. Samson and G.K. Bullard (2002). FI-1045: a profile of a commercially useful isolate of *Metarhizium anisopliae*. *Biocontrol. Sci. Technol*., **12:** 43-58.

Ministry of Agriculture and Land Reclamation - Annual Bulletin of Agricultural Statistics 2016, 2017.

Nayera, Y. Solieman, Rania M. Barghash and S.D. Abou-hussein (2015, April-June). "Impact of the Added Value on the Economic Return of some Horticultural Crops under Egyptian Conditions" *Middle East Journal of Agriculture Research*., **04(02):** 322-33.

Nayera.Y. Solieman, Mohamed Gamal Mady Abu-Azaim and Y. Hamouda (June 2015). "The Influence of Force Molting Process for Poultry Laying Eggs on the Economic Return" *Advances in Environmental Biology*, **9(11):** 169-173.

Nayera Y. Solieman and Rania. M. Barghash (2016). "Economic Efficiency 0f Irrigation Water Usage and Restructuring Cultivation of Agricultural Crops" *International Journal of Chem Tech Research*, **9(10):** 62-71.

Sabbour, M.M. and A. Sahab (2005). Efficacy of some microbial control agents against cabbage pests in Egypt. *J. Pak. Of Biol. Sci*., **10(8):** 1351-1356.

Sabbour, M.M. (2015). Efficacy of some nano-Imidacloprid against red flour beetle *Tribolium castaneum* and confused flour beetle, *Tribolium confusum* (Coleoptera: Tenebrionidae) under laboratory and store conditions. *Advances in Biochemistry & Biotechnology*, 1-13.

Sabbour, M.M. (2018). Pathogenicity of Imidacloprid and its nano against *Rhyzopertha dominica* (Coleoptera: Bostrichidae) under laboratory and store conditions Integrated Protection of Stored Products. *IOBC-WPRS Bulletin*, **130:** 185-191.

Sabbour, M.M. (2018). Role of the Imidacloprid and nano-Imidacloprid on *Callosobruchus chinensis* and *Callosobruchus maculatus* (Coleoptera: Tenebrionidae) under store and laboratory conditions. *Integrated Protection of Stored Products IOBC-WPRS Bulletin*, **130:** 177-184.

Sabbour, M.M. (2017 Feb). Determinations of Imidacloprid and nano- Imidacloprid on some tomato serious pests and their predators. *International Educational applied Scientific research Journal*, **2(2):** e-ISSN: 2456-5040.

Susan, E. Webb and Anthony M. Shelton (1988). Laboratory rearing of the imported cabbageworm. New York food and life science. 1-7.

Sabbour, M.M. (2018). The effect of Imidacloprid and nano-Imidacloprid against *Sitophilus granarius* under laboratory and store conditions. Integrated Protection of Stored Products. *IOBC-WPRS Bulletin*, **130:** 192-198.

Sabbour, M.M. and El-Sayed Hassan Shaurub (2018). Toxicity effect of Imidacloprid and nano-Imidacloprid particles in controlling *Bactrocera oleae* (Rossi) (Diptera: Tephritidae) under laboratory and field conditions. *Bioscience Research*, **01815(3):** 2494-2501.