Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2016, 8(4):506-512

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Determinations of the effect of using silca gel and nano-silica gel against *Tuta absoluta* (Lepidoptera: Gelechiidae) in tomato fields

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ABSTRACT

The effect of both silica gel and nano silica gel were tested under laboratory, green house and field conditions. Results show that , the LC50s of the target insect pests Tuta absoluta under laboratory conditions give, 44, 58, 99, 121, 142, 153 and 155 ppm for Newly hatched larvae, 1st larval instars, 2nd larval instars, 3rd larval instars, 4th larval instars, Adult males and Adult females respectively after treated with silica gel. The LC50s of the target insect pests T. absoluta which give, 18, 22, 30, 33, 41,46 and 49 ppm for Newly hatched larvae, 1st larval instars, 2nd larval instars, 3rd larval instars, 4th larval instars, adult males and adult females respectively after treated with Nano silica gel . Under green house conditions the means number of infestations show, that, after 20 days of application the means number of infestations record 10.0±6.1, 3.1±4.2 after treated with silica gel an d nano- silica gel as compared to 29.2±4.7 Individuals in the con trol. After 50 days of application the means number for the corresponding treatments give 20±3.1, 7.0±1.1 as c ompared to 68±5.5 individuals in the control . At the end of the experiments after120 days, silica gel and Nano silica gel application recorded that, the individuals number 59±2.9, 12.0±4.1 and 99±9.9 individuals in the control. Und er field conditions after the harvest time , the crop of tomatoes weight recorded, 2731± 26.60, 3331± 39.80 Kg/ feddan as compared to 2224± 41.81 Kg/feddan in Fayoum governorate. In Tanta governorate, the weight of tomato recorded 1991± 16.40 , 3451± 16.70 as compared to2030± 56.60 kg/ feddan.

Keywords: silica gel, nano. Nano silica, tomato, yields, infestations, Biocontrol, *Tuta absoluta.*

INTRODUCTION

The tomato crop, *Lycopersicon esculentum* (Mill) is a considered among vegetable crop of the large importance throughout the world. The tomato leafminer, *Tuta absoluta* Meyrick, (Lepidoptera : Gelechiidae) is one of a serious pest of both the outdoor and the greenhouse tomatoes. *T. absoluta* has been among serious threat pasts to tomatoes production damaging both leaf as well as the fruit and if not detected it can devastate and reached to 100% of the drop.

Up until recently the damage to potato crop was limited mainly to the leaf part of the plant. However, during the expansion of *Tuta absoluta* into Egypt, the pest seems to have extended its reach to the potato Tuber as well. Due to its nutritional value and its export potential, currently there are serious efforts, sponsored by many international agencies, to enhance the production of potato in East Africa for the purpose of providing sustainable staple food source in the region as we well as improving farmer's earnings. The new pest can present a serious threat to such efforts and needs to be kept in check as early as possible [1-8]. During the past three years and while expanding eastward from Spain along the North African coast, Tuta absoluta have caused havoc in agricultural production , devastating crops in all countries on the way, elevating prices beyond the capability of average consumer. International aid and development agencies are strongly urged to start early monitoring provide education material to the farmers to identify the risk and plan to act against the pest and limit its damage. Pheromone traps are simple and effective tool to alert farmers to the incoming risk [9-13]. Nowadays, chemical control is still an important way in protecting crops from biological disasters and reducing the yield loss. Compared with chemical pesticides, biopesticides have attracted increasing attention because of its high bio-efficiency, safety, and environmental friendliness. However, as a typical biopesticide, although Avermectin possesses such advantages over chemical pesticides, its conventional formulations still suffer from some shortages, such as environmental sensitivity, poor water solubility, and short duration and low bioavailability, which limited their large-scale applications in crop production. The rapid development of nanoscience and nanotechnology provides new ways to improve the performances of conventional pesticide formulations by constructing nanodelivery system using nanomaterials as carriers. In nanomedicine field, many studies suggested that nanoscale carriers can improve the timed release of drug molecules, enable precisive drug targeting, and enhance the drug bioavailability [14-18]. But limited work has been performed on nanoparticle-based pesticide delivery systems. However, the pesticide nanodelivery system has great potential to precisely control the release of pesticide and remarkably reduce effective dosage by maintaining an effective concentration in the target for longer periods of time [7-9], which is favorable to improve the utilization, reduce the residues of pesticides, and avoid the pollution of environment and agricultural products. Moreover, pesticide nanodelivery systems have been proposed to produce a better spatial distribution on leaf surfaces of crops due to the nanoscale size and thereby improve effectiveness of pesticide applications. Besides, pesticide nanodelivery systems also have better penetration through the cuticle and allow slow and controlled release of active ingredients on the target [5,6]. Silica nanoparticles have attracted many attentions due to their low cost, non-toxicity, high surface area, and high reactivity as drug carriers [10-15]. Although limited works have been done on the pesticide delivery system using silica nanoparticles as carriers [9], some functional defects still need to be improved. Currently, the silica nanoparticles as pesticide carriers did not show controllable porous surface properties, and release of pesticides was generally controlled by adjusting pesticides concentration and the thickness of coating layer, resulting in the relatively limited tuning range of release rate. Moreover, the size uniformity of silica nanocarriers need to be further improved because monodisperse carriers are favorable to promote adhesion and permeability of * Correspondence: cuihaixin@caas.cn the pesticide on target crops[19-23].

[1] controlled the tomato leaf miners by the microbial fungi and *Trichogramma evanesens.* Under laboratory condition the percentage eggs parasitoid of *T. evanesens* were significantly decreased after treatments with *M. anisopliae to 93.2% as* compare to 98.2 in the control. Under green house conditions the means number of infestation were significantly decreased [1].

The aim of this work to determine the effect of silica gel and nano silica gel against *T. absoluta* under laboratory, green house and tomato field conditions.

EXPERIMENTAL SECTION

2.1. Rearing insect pests:

The tomato pinworm were reared on tomato leaves under laboratory conditions 22±2Co and RH 60-70% *T. absoluta* used in the trials were obtained from laboratory cultures. The experiments were repeated 4 times. The percentages of mortality were calculated and corrected according to [24], while LC50 was calculated through probit analysis, [25]. The experiments were carried out under laboratory conditions 22 ± 2o C and 60-70% R.H. Twenty individuals of the third larvae of *T. absoluta* were put on them, covered with muslin. Control (untreated) was made by feeding the larvae on untreated leaves (sprayed by water only). The experiments were repeated 4 times. The percentages of mortality determined after seven days. The percentages of mortality were counted and calculated according to [24], while Lc50 were calculated through probit analysis [25]. The experiments were carried under laboratory conditions; 22 ± 2o C and 60± 5 % RH.

2.2 Green house trials:

Tomato plant Winter Variety Platenium-5043 was planted in the green house in 40 plots in each artificial infestation was made by spraying the plant with the silica gel at the concentrations of and 5g/l . Control samples were sprayed by water only. The plants were examined every two days, the percentage of infestation was calculated until the end of the experiment. Each treatment was replicated 4 times. The percent mortality was counted and corrected according to Abott, 1925; while Lc50s were calculated through probit analysis after [25]

2.3. Field trials

The experiments were carried out to study the effectiveness of the tested silicagel and *nano* silicagel against the target insect pests in two different areas. These two areas were: El-Fayoum and Tanta. Tomato planted Winter Variety Platenium-5043 planted on the end of Septamber in an area of about 1600 m^2, and divided into 16 plots of 50 m2 each. Four plots were assigned for each silica gel , while 4 plots were treated with water and used as the controls. Silica gel Treated t 5g/ml . Treatments were performed in a randomized plot design at sunset. A five-litre sprayer was used to spray on the treatments. Three applications were made at one week intervals, at the commencement of the experiment. Twenty plant samples were randomly collected at certain time intervals from each plot and transferred to the laboratory for examination. The average number of each of the tested pests/ sample/ plot/treatment was calculated 21, 45 and 120 days after the 1st application. The infestations of target insect pests were then estimated in each case. After harvest, the yield of each treatment was weighed as kgs/feddan.

2.4. Nanoencapsulation

Nanoencapsulation is a process through which a chemical is slowly but efficiently released to the particular host for insect pests control. Release mechanisms include dissolution, biodegradation, diffusion and osmotic pressure with specific pH [26]. Encapsulated of the two isolated bacteria HD-703 and HD-95 nano-emulsion is prepared by high-pressure homogenization of 2.5% surfactant and 100% glycerol, to create stable droplets which that increase the retention of the oil and cause a slow release of the nano materials . The release rate depends upon the protection time; consequently a decrease in release rate can prolong insect pests protection time [27].

RESULTS

1 show that , the LC50s of the target insect pests *T. absoluta* which give, 44, 58, 99, 121, 142, 153 and 155 ppm for Newly hatched larvae, 1st larval instars, 2nd larval instars, 3rd larval instars, 4th larval instars, Adult males and Adult females respectively (Table 1).

Table 1.Effect of silicagel against the different stages of *T. absoluta* under laboratory conditions

Insects	LC_{50}	Slope	variance	95%confidence limits
Newly hatched larvae	44	0.1	1.01	30-69
1st larval instars	58	0.2	1.01	35-98
2nd larval instars	99	0.4	1.01	77-117
3rd larval instars	121	0.3	1.01	97-142
4th larval instars	142	0.2	1.01	101-143
Adult males	153	0.1	1.02	111-168
Adult females	155	0.1	1.02	128-185

Table2 .Effect of Nano-silica gel against the different stages of *T. absoluta* under laboratory conditions

Insects	LC_{50}	Slope	variance	95%confidence limits
Newly hatched larvae	18	0.1	1.01	30-36
1st larval instars	22	0.2	1.01	15-68
2nd larval instars	30	0.4	1.01	27-99
3rd larval instars	33	0.3	1.01	27-102
4th larval instars	41	0.2	1.01	31-83
Adult males	46	0.1	1.02	29-78
Adult females	49	0.1	1.02	28-95

Table 2 show that , the LC50s of the target insect pests *T. absoluta* which give, 18, 22, 30, 33, 41,46 and 49 ppm for Newly hatched larvae, 1st larval instars, 2nd larval instars, 3rd larval instars, 4th larval instars, Adult males and Adult females respectively (Table 2).

The effect of the pathogen used were shown in Table 3 which detect that, under green house conditions the means number of infestations show, that, after 20 days of application the means number of infestations record 10.0±6.1, 3.1±4.2 after treated with silica gel and nan0- silica gel as compared to 29.2±4.7 Individuals in the control. After 5o days of plication the means number for the corresponding treatments give 20±3.1, 7.0±1.1 as compared to68±5.5

individuals in the control. At the end of the experiments after120 days, silica gel and Nano silica gel application recorded that, the individuals number 59±2.9, 12.0±4.1 and 99±9.9 individuals in the control (Table 3).

Table (3): Effect of silica gel against *T. absoluta* under greenhouse conditions

Treatments	Days after treatment	Means of infestations (Means ± S.E.)
Control	20	29.2±4.7
	50	68±5.5
	90	78±9.9
	120	99±9.9
Silicagel	20	10.0±6.1
	50	20±3.1
	90	30±1.8
	120	59±2.9
Nano-silicagel	20	3.1±4.2
	50	7.0±1.1
	90	10.2±6.1
	120	12.0±4.1
F –test	14.4	
LSD 5%	13.8	

Table (4): Weight of harvested tomato into two Egyptian regions after silica gel and nano-silica gel treatment against *T. absoluta* during seasons 2015

Treatments	Fayoum Weight tomatoes (Kg/feddan)	Tanta Weight tomatoes (Kg/feddan
Control	2224± 41.81	2030± 56.60
Silica gel	2731± 26.60	2991± 16.40
Nano- silica gel	3331± 39.80	3451± 16.70
F –test	34.1	
LSD 5%	18.3	

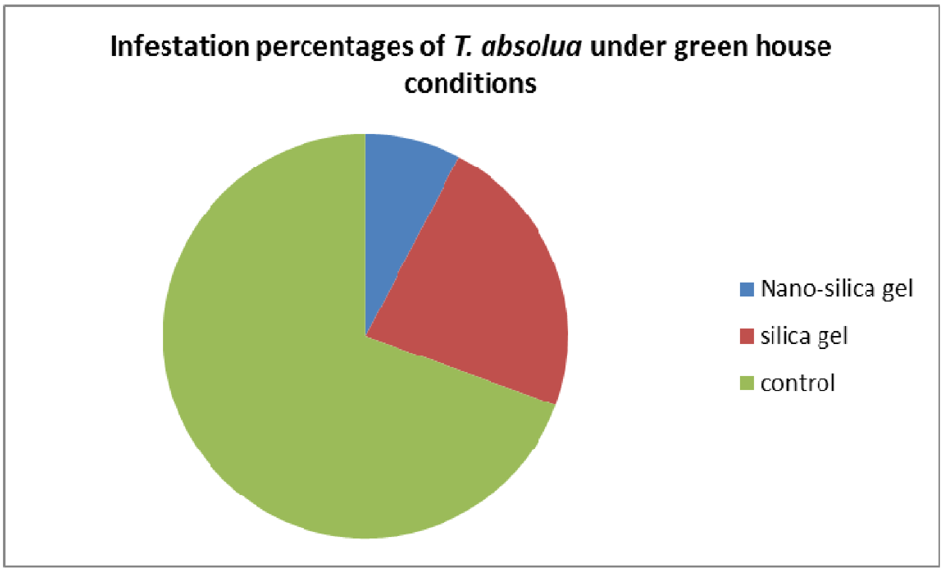

Fig1. Infestation percentages of *T. absolua* under green house conditions

Under field conditions after the harvest time , the crop of tomatoes weight recorded, 2731± 26.60, 3331± 39.80 KG/ feddan as compared to 2224± 41.81 Kg/feddan in Fayoum governorate. In Tanta governorate, the weight of tomato recorded 1991± 16.40 , 3451± 16.70 as compared to2030± 56.60 kg/ feddan (Table 4).

The infestations percentages showmen in figures 1 and 2 which that the infestation of the target insect pests *T. absolua* significantly decreased after Nano silica gel treatments under both green house and field conditions, figure

3 show the silica gel particles photo with scanning microscopy, fig 3, a Nano silica at 50 nanometer and fi 3 b is a photo of Nano silica at 100 Nano meter.

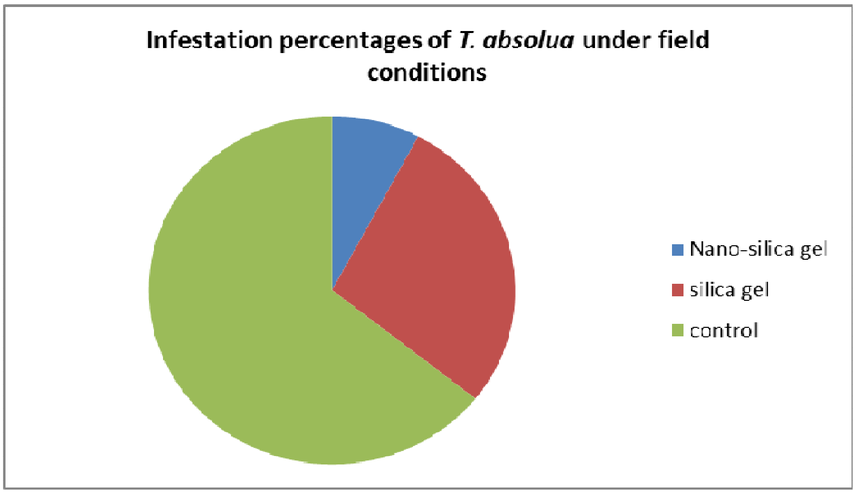

Fig2. Infestation percentages of *T. absolua* under field conditions

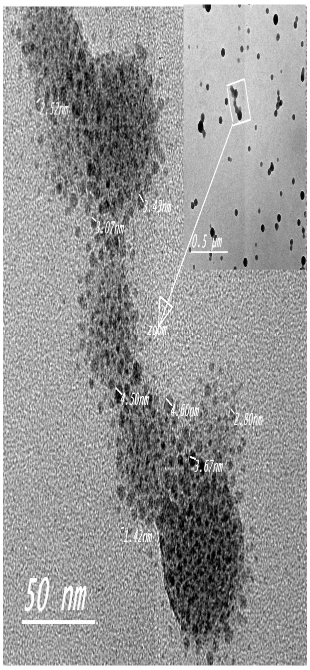

Figure 3 show the particles of the nano silica gel under scanning electron microscopy

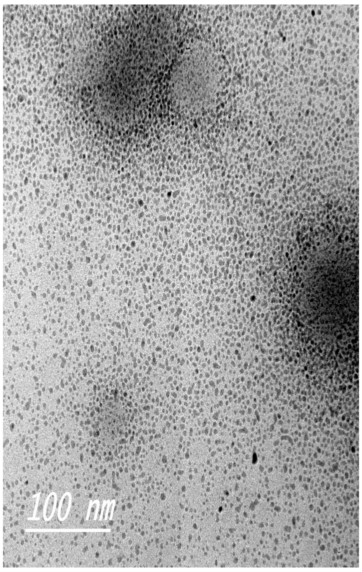

Figure. (3 a andb), scanninigng electron microscopy
a. Scanning electron microscopy 50 nano meter
b. Scnning electron microscopy 100 nano meter

DISCUSSION

[26-29] agree with our results and control a lot of pests with nano materials. {30-41] have the same results obtained and show that the nano pesticides is a perfect for controlling mny pests and diseases . [40-45] found the insecticidal activity the nano-silicagel (CS-g-PAA) showed highest effect against the three insect of soybean. as the means number of eggs deposited /female were significantly decreased. Under laboratory and semifield condition, *Aphis gossypii* were significantly decreased to 20.9±9.1 and 28.9±9.2 eggs/female respectively as compared to 97.3±4.9 and 90.3±4.9 eggs/female in the control, respectively. The same trends were also observed against *Callosobruchus maculatus*. Sabbour 2015, a, b, c found that the nano insecticides of Imidacloprid and fungi strains cases a higher mortality for insect infestations. Our results agree with [43,44] who find that the nano pesticide decrease the infestation percentage of different pests.

Acknowledgment
This research was supported by project titled, biological control of some greenhouse tomato insect pests.

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