

**EFFICIENCY OF SILICA NANOPARTICLES, TWO BIOINSECTICIDES, PEPPERMINT EXTRACT AND INSECTICIDE IN CONTROLLING COTTON LEAFWORM, *Spodoptera littoralis* BOISD. AND THEIR EFFECTS ON SOME ASSOCIATED NATURAL ENEMIES IN SUGAR BEET FIELDS**



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### **ABSTRACT**

This experiment was carried out at El-Riad region, Kafr El-Sheikh Governorate during two sugar beet successive seasons, 2013 and 2014. The aim of this study examined the efficiency of silica nanoparticles, bioinsecticides (Dipel 2X and Biofly), peppermint extract and insecticide (Match 50% EC) in controlling the cotton leafworm, *Spodoptera littoralis* (Boisd.) and their effects on some associated natural enemies in sugar beet. Results showed that the chemical insecticide (marshal) was the highest efficiency in controlling the cotton leafworm flowed by silica nanoparticles in high rate. Data showed also the extract of peppermint attractive the natural enemies to sugar beet filed and made moderate control the cotton leafworm.

**Keywords:** Cotton leafworm, sugar beet, silica nanoparticles, peppermint extract, natural enemies

### **INTRODUCTION**

Sugar beet is an important and vital crop in Egypt, that was introduced to share sugar-cane in satisfying the requirements of sugar production in Egypt. This crop is subjected to infestation with its specific insects. However, in some cases, some common insect pests like the cotton leafworm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) could be more dangerous than specific ones. This occurs with the early sugar beet plantation sown in early September, because Ministry of Agriculture in Egypt encourages the farmers to widen the duration of sowing sugar beet to facility the work in factories of excluding sugar. Because the climate change that keeps the temperature relatively high throughout September, the insect can severely attack the seedlings of sugar beet causing large bare batches in the field and results in high economic losses (Shalaby, 2001; Helal, 2004; Abou El-Kassem, 2010; Bazazo, 2010 and El-Mahalawy, 2011).

The cotton leaf worm *S. littoralis* is considered as the major pest in a wide range of cultivation including cotton, corn, soybeans, peanuts and vegetables. In Egypt this pest is widely spread as well as in other Middle East countries in addition to temperate zones in Asia and Africa. This insect is very prolific pest whose female lay hundreds of eggs in egg masses, and the larvae pass through six instars in 15 to 23 days (Miyahara *et al.*, 1971).

Many insecticides have been tested against this pest Haas- Stapleton *et al.*, (2003) the use of insecticides in agriculture field causes biological imbalance Yadav (2010) some new eco- friendly formulations pesticides became the target Cloyd and Bethke (2011) the pest resurgence again because it accepted resistance (Haas-Stapleton *et al.*, 2003). The use of insecticides in agriculture field causes disturbance between beneficial insects and harmful insects (Yadav 2010). Zhang and Xiao-Zhen, (2010) and Cloyd and Bethke (2011), mentioned that, some new eco-friendly formulations pesticides became the target to control the pests.

The need for new safe method and effective insecticides became necessary nowadays after the increase of environmental pollution and insect resistance to chemical insecticides.

Nanotechnology employs nanoparticles that are made of inorganic or organic materials that are defined by having one or more dimensions in the order of 100 nm or less (El-bendary and El-Helaly, 2013).

The different types of silica have different specific surface area, particle size, drying loss, ignition loss and structure, which may affect their insecticidal activity. They are very light powders, are the most effective of all inert dusts and have an acute rat LD<sub>50</sub> of 3160 mg.kg<sup>-1</sup> (Ebeling 1971).

The field application of silicon to susceptible rice and wheat cultivars increased crop tolerance and reduced pest infestation (El-Samahy, 2002; Basagli *et al.*, 2003 and Ecole and Sampaio, 2004).

The new nanotechnology with materials having unique properties than their macroscopic or bulk counter parts, has promised applications in various fields. The essence of nanotechnology is the ability to work at the molecular level, atom by atom, to create large structures with fundamentally new molecular organization. The aim is to exploit these properties by gaining control of structures and devices at atomic, molecular, and supra molecular levels and to learn to efficiently manufacture and use these devices. Nanotechnology has provided new solutions to problems in plants and food science and offers new approaches to the rational selection of raw materials, or the processing of such materials to enhance the quality of plant products.

The application of silicon in crops provides a viable component of integrated management of insect pests and diseases because it leaves no pesticide residues in food or the environment and can be easily integrated with other pest management practices Laing *et al.*, (2006). The field application of silicon to susceptible wheat cultivars increased crop resistance and reduced pest infestation Basagli *et al.*, (2003); Ecole and Sampaio (2004).

Whiteley and Schnepf (1986) have shown that biological control of lepidopteran insect pests, affecting crop plants, is possible using *Bacillus thuringiensis*. Lepidopteran of the Noctuidae family, such as *S. littoralis* is susceptible to toxin of *B. thuringiensis* (Sanchis *et al.*, 1994). Biopesticide products containing *B. thuringiensis* account for more than 20% of the biopesticides used worldwide (Sanchis *et al.*, 1996). In Egypt, Salama and Foda (1982), Salama *et al.* (1982) and Salama *et al.* (1990) identified *B. thuringiensis* var. *entomocidus* as a highly effective strain against larvae of *S.*

*littoralis*. El-Husseini *et al.* (2004) produced the conidiospores of *Beauveria bassiana* in two formulations for spraying and dusting applications in sugar beet fields. Populations of insect pests feeding by chewing all leaf tissue were considerably reduced by either technique, thus, *S. littoralis* population was reduced in sugar beet fields using this entomopathogenic fungus.

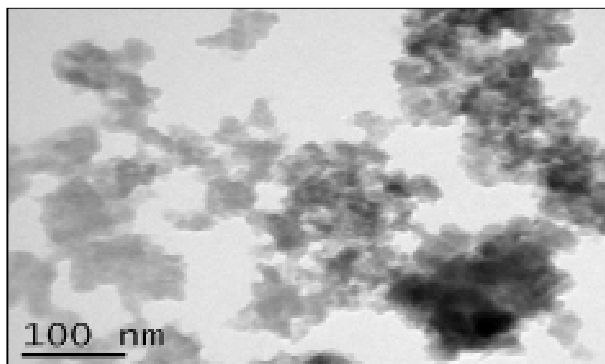
The aim of this study was to evaluate the efficiency of silica nanoparticles, two bioinsecticides, peppermint extract and insecticide in controlling the infestation with *Spodoptera littoralis* on sugar beet plants under field conditions and the side effect on associated predators.

## MATERIALS AND METHODS

### 1. Tested materials:

#### Silica nanoparticles:

The silica nanoparticles was obtained from Nanotech Egypt Company Limited, Cairo, Egypt. It's size was 20 nm with a purity of 99.99%. The Transmission Electronic Microscope (TEM) image of the silica nanoparticles is shown in Fig. 1. Five concentrations were used (15, 30, 45, 60 and 75 g/fed.).



**Fig. (1): The shape and size of silica nanoparticles.**

#### Bioinsecticides:

Dipel 2X (*Bacillus thuringiensis*) at 300 g/fed. and biofly (*Beauveria bassiana*) at 300 ml/fed.

#### Aromatic plant extract:

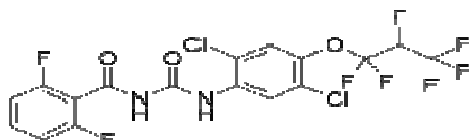
Peppermint *Mentha piperita* L. use by 150 g/fed.

#### Insecticide:

Match 50% EC at 160 cm<sup>3</sup>/fed.

Active Ingredient: Lufenuron

Structural formula



## 2. Field experiment:

### Reduction percentage of *Spodoptera littoralis* (Boisd.) resulted from treatments:

This experiment was carried out at El-Riad region, Kafr El-Sheikh Governorate during two sugar beet successive seasons, 2013 and 2014. Experimental area was prepared, and sown with Pleno sugar beet cultivar on first of August every season. This date of sowing was selected to mimic the infestation of cotton leafworm, *S. littoralis* occurs in sugar beet fields sown on early August, when the temperature is high. All recommended cultural practices were applied along the growing seasons without insecticide applications.

The experimental area was divided into plots each of 1/100 feddan, and the treatments were arranged in randomized complete blocks (RCB) with 4 replicates. When the larval population density reached minimum two larvae/plant started to examine five concentrations of silica nanoparticles, Dipel 2X (*B. thuringiensis*), Biofly (*B. bassiana*), peppermint and Match. Each concentration from different treatments was sprayed on sugar beet plants in the open field, using knapsack sprayer (20 L volume). Each sample from one replicate is 10 plants counted in the field. Larvae of *S. littoralis* were counted before spraying and 2, 5, 7, and 15 days after treatments. The reductions in populations were calculated using Henderson and Tilton (1955) equation as follows =

$$\% \text{ Population reduction} = 100 \times \left( 1 - \frac{Ta \times Cb}{Tb \times Ca} \right)$$

#### Where:

Ta: Population in treated plots after treatment.

Tb: Population in treated plots before treatment.

Ca: Population in control after treatment.

Cb: Population in control before treatment.

### Reduction percentage of natural enemies resulted from treatments:

Numbers of *Chrysoperla carnea* (larvae), *Coccinella* sp. (adults and larvae) and true spiders were counted per 10 sugar beet plants just before treatments, and then 2, 5, 7, 10 and 15 days after treatments. Also, the reduction in natural enemies were calculated with the same equation.

#### Statistical Analysis:

The obtained data were treated statistically according to the method of Duncan Multiple Range Test (Duncan, 1955).

## RESULTS AND DISCUSSION

### 1- Reduction in *Spodoptera littoralis* larvae:

Data in Table (1) showed the reduction percentage of *S. littoralis* resulted from using silica nanoparticles (SiNPs) (five concentrations),

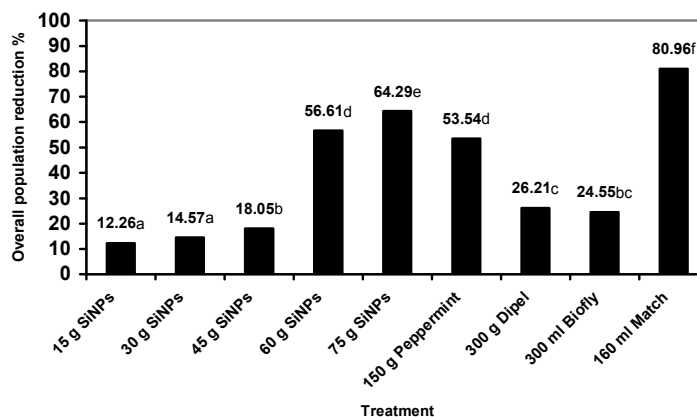
biopesticides (Dipel 2X and Biofly) and insecticide (Match) during two successive seasons; 2013 and 2014 under sugar beet field conditions.

Table (1) showed results of treated sugar beet to control *S. littoralis* larvae with examined materials. After two days of treatments the insecticide (Match) was highly effective which recorded 80.50% reduction of larvae numbers followed by high rate of SiNPs (70 g/fed) followed by 60 g/fed SiNPs with 70.00 and 64.33% reduction, respectively. After one week match, SiNPs (75 g), peppermint and SiNPs (60 g) were recorded 84.75, 69.75, 61.75 and 54.50% reduction in larvae numbers, respectively. While the lowest reductions were recorded in using SiNPs with low concentrations 15 and 30 g/fed.

**Table (1): Reduction percentage of *S. littoralis* on sugar beet under field conditions at El-Riad region, Kafr El-Sheikh Governorate during 2013 season.**

Treatment	Rate/fed.	Days after treatment				
		2	5	7	10	15
Silica nanoparticles	15 g	12.33	18.00	13.50	9.99	7.50
	30 g	14.50	19.11	16.50	13.99	8.75
	45 g	21.25	23.50	20.25	14.75	10.50
	60 g	64.33	72.00	54.50	48.70	43.50
	75 g	70.00	80.10	69.75	52.25	49.33
Peppermint	150 g	22.33	60.12	61.75	63.99	59.50
Dipel 2X	300 g	29.25	31.55	26.00	23.25	21.00
Biofly	300 ml	27.75	24.75	40.90	15.33	14.00
Match	160 ml	80.50	82.90	84.75	80.00	76.66

Overall average (Fig. 2) of the population reduction of *S. littoralis* larvae under sugar beet field conditions. The statistical analysis showed significant differences between treatments.



**Fig. (2): Overall population reduction percentage of the cotton leafworm, *S. littoralis* numbers after treatments during 2013 seasons.**

Means followed by a common letter are not significantly different at the 5% level by DMRT

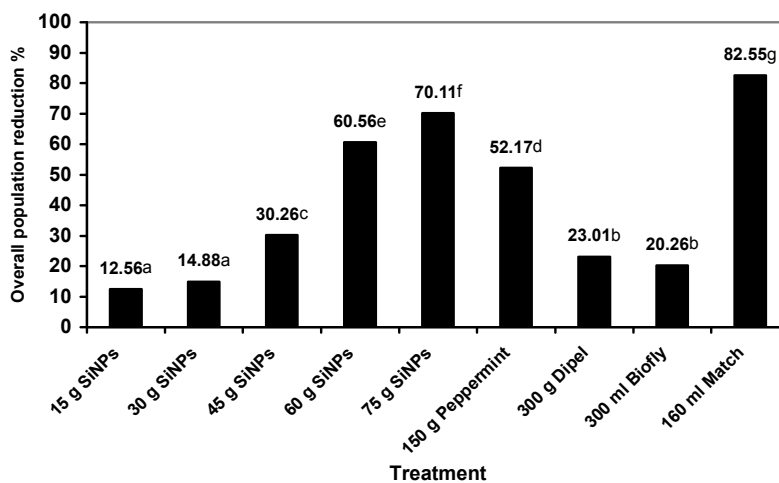
The highest obtained from using the chemical insecticide (match) (80.96%) followed by SiNPs with high rate (75 g/fed) which recorded 64.29% reduction. Data showed there are not significant differences among SiNPs (60 g/fed) and peppermint; and represented by 56.61 and 53.54% reduction, respectively. The bioinsecticides; dipel 2X and biofly were showed 26.21 and 24.55% reduction, respectively without significantly differences.

During the second season 2014, results in Table (2) showed after two days of treatments the chemical insecticide (match) was recorded 82.33% reduction in *S. littoralis* larvae followed by SiNPs (75 and 60 g/fed.).

**Table (2): Reduction percentage of *S. littoralis* on sugar beet under field conditions at El-Riad region, Kafr El-Sheikh Governorate during 2014 season.**

Treatment	Rate/fed.	Days after treatment				
		2	5	7	10	15
Silica nanoparticles	15 g	11.2	16.23	17.12	10.02	8.21
	30 g	15.52	20.12	17.12	14.55	7.11
	45 g	18.33	30.11	33.21	35.25	34.4
	60 g	55.61	75.22	60.33	61.22	50.44
	75 g	66.21	81.33	79.37	60.11	63.51
Peppermint	150 g	45.33	60.26	49.55	55.47	50.22
Dipel 2X	300 g	12.51	33.26	28.53	22.32	18.41
Biofly	300 ml	18.43	26.41	33.67	12.36	10.44
Match	160 ml	82.33	83.41	86.44	88.32	72.23

Fig. (3) showed the overall average of population reduction percentage of the cotton bollworm, *S. littoralis* numbers after treatments. The statistical analysis showed significant differences between treatments.



**Fig. (3): Overall population reduction percentage of the cotton leafworm, *S. littoralis* numbers after treatments during 2014 seasons.**

Means followed by a common letter are not significantly different at the 5% level by DMRT While the insecticide (match) was highest effectiveness which recoded 82.55% reduction followed by SiNPs (75 and 60 g/fed.) with 70.11 and 60.56% reduction, respectively. The peppermint extract recoded 52.17% reduction. The bioinsecticides, dipel 2X and biofly were recorded 23.01 and 20.26% reduction, respectively without significantly.

Although the chemical insecticide (match) showed the highest effectiveness in controlling the cotton leafworm, *S. littoralis* in sugar beet field but the pest resurgence again because it accepted resistance (Haas-Stapleton *et al.*, 2003). The silica nanoparticles enhanced the plant tolerance against cotton leafworm (Borei *et al.*, 2014 and El-Samahy, 2015).

**2- Reduction in some natural enemies associated with *Spodoptera littoralis* (Boisd.):**

Data in Table (3) showed the reduction percentage in some natural enemies associated with cotton leafworm, *S. littoralis* under sugar beet filed during two seasons; 2013 and 2014.

The chemical insecticide (match) showed the highest negative side effect on examined natural enemies; *C. carnea*, *Coccinella* spp. and true spiders at mean 80.64, 84.13 and 47.46% reduction, respectively during two seasons. The highest concentrations of SiNPs showed come in the second order in negative side effect which recorded 52.74, 40.13 and 37.28% reduction at *C. carnea*, *Coccinella* spp. and true spiders, respectively.

On the other hand peppermint showed positive effect while it increased the population of examined natural enemies *C. carnea*, *Coccinella* spp. and true spiders at 47.76, 55.19 and 21.88% increase.

**Table (3): Reduction in some natural enemies associated with cotton leafworm, *S. littoralis* on sugar beet at El-Riad region, Kafr El-Sheikh Governorate during two seasons.**

Treatment	Rate/ fed.	<i>Chrysoperla carnea</i>			<i>Coccinella</i> spp.			True spiders		
		Mean		Mean	Mean		Mean	Mean		
		2013	2014		2013	2014		2013	2014	
Silica nanoparticles	15 g	26.36	27.12	26.74	21.25	21.00	21.13	20.66	20.00	20.33
	30 g	31.15	33.00	32.08	27.33	26.12	26.73	24.25	23.75	24.00
	45 g	39.23	41.25	40.24	30.12	30.01	30.07	27.33	27.01	27.17
	60 g	45.45	46.00	45.73	36.14	35.14	35.64	31.25	31.00	31.13
	75 g	52.36	53.12	52.74	40.25	40.00	40.13	37.45	37.11	37.28
Peppermint	150 g	-47.33	-48.19	-47.76	-55.35	-55.03	-55.19	-22.00	-21.75	-21.88
Dipel 2X	300 g	40.12	41.33	40.73	45.25	44.75	45.00	28.50	28.25	28.38
Biofly	300 ml	49.15	50.12	49.64	45.12	44.55	44.84	41.50	41.25	41.38
Match	160 ml	80.13	81.14	80.64	84.25	84.00	84.13	47.76	47.15	47.46

In conclusion, the chemical insecticide (match) showed the highest effect in controlling the cotton leafworm, *S. littoralis* on sugar beet field followed by SiNPs. Although the SiNPs come in the second order in

controlling *S. littoralis* after recommended insecticide (March) but results showed that it have negative effect on natural enemies so we can use these material in protect plants or the number of natural enemies were low. Results showed also, the plant extract (peppermint) was high attractive to natural enemies, so can use these extract to increase the number of natural enemies (Khafagy, 2011). The two bioinsecticides (Dipel 2X and Biofly) showed low effectiveness in controlling the cotton leafworm and reduce the number of associated predators.

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**كفاءة السيليكا النانومترية ومبيدين حيويين ومستخلص النعناع في مكافحة دودة ورق القطن (أسبودبترأ لیتورالیس) وتأثيراتها على بعض الأعداء الحيوية المصاحبة في حقول بنجر السكر**  
مجدى فاروق محمد السماحى ، إبراهيم فتحى خفاجى و أسماء محمد على الغبارى  
معهد بحوث وقاية النباتات ، محطة البحوث الزراعية بسخا ، كفر الشيخ ، مركز البحوث الزراعية ، مصر

أجريت هذه التجربة بمنطقة الرياض بمحافظة كفر الشيخ لموسمين متتالين ٢٠١٣ و٢٠١٤م. وكان الهدف من هذه الدراسة تقييم فعالية السيليكا النانومترية ومبيدين حيويين (الدابيل والبيوفلاي) ومستخلص النعناع ومقارنتهم بالمبيد الحشرى (ماتش) على دودة ورق القطن في محصول بنجر السكر. ولقد أظهرت النتائج أن المبيد الكيماوى (ماتش) كان الأكثر فعالية في مكافحة الحشرة محل الدراسة تلاه السيليكا النانومترية بالتركيزات المرتفعة. علاوة على ذلك كان المبيد الكيماوى هو أكثر المعاملات في خفض تعداد الأعداء الحيوية المصاحبة لدودة ورق القطن في بنجر السكر في حين أن مستخلص النعناع جذب تعداداً أكثر من الأعداء الحيوية بما يؤدي لزيادة تواجد الأعداء الحيوية.