J. Plant Prot. and Path., Mansoura Univ., Vol.6 (8): 1155 - 1162, 2015

EFFICIENCY OF SILICA NANOPARTICLES COMPARED WITH CERTAIN BIO-INSECTICIDES, MINERAL OIL AND INSECTICIDE ON COTTON BOLLWORMS UNDER FIELD CONDITIONS AT EL-RIAD REGION, KAFR EL-SHEIKH GOVERNORATE

Asmaa M. A. El-Ghobary and M. F. M. El-Samahy.
Plant Protect. Res. Inst. (PPRI), Agric. Res. Station (ARS), Sakha, Kafr El-Sheikh, Egypt

ABSTRACT

This experiment was carried out at El-Riad region, Kafr El-Sheikh Governorate to estimate the efficiency of silica nanoparticles compare with bio-insecticides, mineral oil and the conventional insecticide (Dursban H) on reducing the population of the cotton bollworms; pink bollworm, *Pectinophora gossypiella* (Saunders) and spiny bollworm, *Earias insulana* (Boisd.) in cotton fields during 2013 and 2014 seasons. Data showed that Dursban H in two sprays was the highest effective. Silica nanoparticles came in the second order with high concentration (200 ppm) followed by low concentration of silica nanoparticles (100 ppm) during the two successive cotton seasons. However, Biovar (*Beauveria bassiana*) was the least effective. The efficiencies of the tested compounds were significantly differences according to the population reduction of the two cotton bollworms.

Keywords: cotton bollworms, silica nanoparticles, control

INTRODUCTION

Cotton, *Gossypium barbadence* L. is one of the most important economical crops in Egypt and all over the world where it is employed in several industrial productions *i.e.* ginning, textile, food oil, soap, furniture and many other industries, as well as a source of foreign coin when exported to another countries. The second staple variety is the Long Staple cotton or “Giza 86” which represents 70% of Egypt’s total cotton production and is grown in the Nile Delta area (Hamza & Maldonado 2012). In Egypt, cotton plants are usually subjected to be attacked by numerous insect pests Al-Shannaf (2010). Cotton bollworms are the most destructive pests infesting cotton plants. The pink bollworm, *Pectinophora gossypiella* (Saunders) and spiny bollworm, *Earias insulana* (Boisd.) cause the greatest number of yield losses from nearly one million hectares cultivated annually (Amin & Gergis 2006).

Several authors studied the effect of most chemical insecticides and some alternative methods to control cotton bollworms under field conditions (Khidr *et al.* 1996, El-Dessouki *et al.* 2006 and Abd El-Maged *et al.* 2007).
Nanotechnology has being embraced in the world of pesticides and pest control Harper, (2010) and has a potential to revolutionize modern day agriculture pest control, different groups of nano pesticide overcome like insecticides, fungicides, herbicides Matsumoto *et al*., (2009). The new

nanotechnology with materials having unique properties than their macroscopic or bulk counter parts, has promised applications in various fields. Due to several problems caused by misuse of insecticides for controlling insects such as pollution, resistance and harmful effect on human and animal health, led to use alternative materials against some insects which attack cotton plants. Borei *et al.,* (2014) showed silica nanoparticles is effective to control cotton leafworm, *Spodoptera littoralis* in soybean under laboratory conditions.

Silicon also improves crop yield (Snyder *et al.*, 2007), and particularly improves the tolerance of plants to biotic and abiotic stress (Epstein and Bloom, 2005).

The present work aims to study the efficiency of silica nanoparticles (SiNPs) compared with bio-insecticides, mineral oil and chemical insecticide against cotton bollworms (*P. gossypiella and E. insulana*).

MATERIALS AND METHODS

This experiment was carried out at El-Riad region, Kafr El-Sheikh Governorate to estimate the efficiency of silica nanoparticles compared with bio-insecticides, mineral oil and the conventional insecticide (Dursban H) on reducing the population of cotton bollworms in cotton fields during 2013 and 2014 seasons. The cotton field was cultivated with variety Giza 86 in the fourth week of March during the two seasons of this study. 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 each plots was isolated from each other by planted area (1m width) that separated replicates. All agricultural practices were followed. Dorsal motor (20 l) with one nozzle was used to spray the tested compounds.

Procedures of evaluating treatments used against cotton bollworms:

Cotton plots assigned for evaluating the efficiency of each one of the compounds in reducing the cotton bollworms infestation as compared with the conventional insecticides tested compounds were sprayed in successive times on 23rd July and 11th Aug. by using dorsal motor (20 l) during 2013 and 2014 cotton seasons. The rate of examined materials illustrated in Table (1).

To estimate the bollworms infestation in green boll, sample of 100 green bolls per 4 plots for each of the tested compounds were collected at random before spray treatment and then after 2, 5, 7, 10 and 15 days after spraying. Percent reduction in infestation was estimated using Henderson and Tilton (1955) formula to determine the initial effect (after 2 days of spraying and the residual effect (after 5, 7, 10 and 15 days of spraying) of tested compounds.

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.

Table (1): Rate of certain materials for controlling cotton bollworms in cotton under field conditions.

Trade name	Common name	Chemical class	Rate/fed.
Dursban H	Chlorpyrifos	organophosphate	1 liter
Biovar	*Beauveria bassiana*	Biological insecticides	800 ml
Protecto	*Bacilluis thuiringiensis*	Biological insecticides	300 g
KZ oil	Mineral oils	--------	2 liter
Silica nanoparticles	Silica nanoparticles	--------	100 ppm
			200 ppm

Statistical Analysis:

Data were statistically analyzed using analysis of variance techniques appropriate to RCB Design upon obtaining significant difference; least significant (LSD) test was used for comparison among the treatment means according to Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

1.The effect on the pink bollworm, *Pectinophora gossypiella* (Saunders):

Results as shown in Tables 2 and 3 indicate the effect of the tested treatments on *P. gossypiella* during the two seasons; 2013 and 2014 under filed conditions. After two days of the first spray, Dursban H showed the highest effective which recorded 57.14 and 40.00% reduction during two seasons, respectively. After two days of the second spray the highest concentration of silica nanoparticles shown the highest reduction of infestation which recorded 60.00 and 45.00% reduction during the two seasons, respectively.

Table (2): Reduction percentage of the pink bollworm, *Pectinophora gossypiella* as a result of use certain treatments during 2013 season at El-Riad region, Kafr El-Sheikh Governorate under field conditions.

Treatment	Rate/fed	Treatment date	Population reduction %					
			2 days	5 days	7 days	10 days	15 days	Average
Dursban H	1 l	23 July	57.14	55.00	83.33	55.00	75.00	65.50
		11 Aug.	40.00	43.75	50.0	82.35	81.25	59.47
Biovar	800 ml	23 July	2.04	31.43	14.29	22.86	21.43	18.41
		11 Aug.	41.82	38.64	18.18	35.83	38.64	34.62
Protecto	300 g	23 July	31.43	28.00	13.33	52.00	25.00	29.95
		11 Aug.	36.00	40.00	26.67	43.53	40.00	37.24
KZ oil	2 l	23 July	14.29	4.00	60.00	52.00	30.00	32.06
		11 Aug.	31.43	25.00	14.29	39.50	46.43	31.33
Silica nanoparticles	100 ppm	23 July	25.00	10.00	16.67	47.00	62.50	32.23
		11 Aug.	46.67	25.00	50.00	41.18	62.50	45.07
	200 ppm	23 July	42.86	20.00	48.15	73.33	55.56	47.98
		11 Aug.	60.00	62.50	37.5	55.83	71.88	57.54

Table (3): Reduction percentage of *Pectinophora gossypiella* as a result of use certain treatments during 2014 season at El-Riad region, Kafr El-Sheikh Governorate under field conditions.

Treatment	Rate/fed.	Treatment date	Population reduction %					
			2 days	5 days	7 days	10 days	15 days	Average
Dursban H	1 l	23 July	40.00	71.43	87.50	88.89	81.82	73.93
		11 Aug.	31.25	38.89	50.00	100.00	50.00	54.03
Biovar	800 ml	23 July	0.00	14.29	12.50	22.22	27.27	15.26
		11 Aug.	31.25	38.89	25.00	8.33	0.00	20.69
Protecto	300 g	23 July	0.00	16.67	16.67	35.19	54.55	24.62
		11 Aug.	8.33	18.52	33.33	23.61	33.33	23.42
KZ oil	2 l	23 July	20.00	14.29	37.50	55.56	0.00	25.47
		11 Aug.	12.50	11.11	18.18	58.33	45.45	29.11
Silica nanoparticles	100 ppm	23 July	0.00	42.86	50.00	58.33	18.18	33.87
		11 Aug.	38.89	18.52	55.56	49.07	66.67	45.74
	200 ppm	23 July	16.67	52.38	47.92	62.96	62.12	48.41
		11 Aug.	45.00	26.67	80.00	26.67	60.00	47.67

Data show that during two seasons (Fig. 1), Dursban H in two sprays was the highest effective recorded 62.28 and 63.98% (av. of two sprays). Silica nanoparticles came in the second order with high concentration (200 ppm) recorded 52.76 and 48.04% reduction (av. of two sprays) followed by low concentration of silica nanoparticles (100 ppm) which recorded 36.65 and 39.81% reduction during two successive cotton seasons. However, Biovar (*B. bassiana*) was the least effective, recording 26.52 and 17.98%, respectively. The efficiencies of tested compounds differed significantly.

The obtained results agree with those of Bramhankar *et al.* (1990) and El-Ghobary (2011) who reported that chemical insecticide is the most efficient compounds compared with other treatments to control the pink bollworm, *P. gossypiella*.

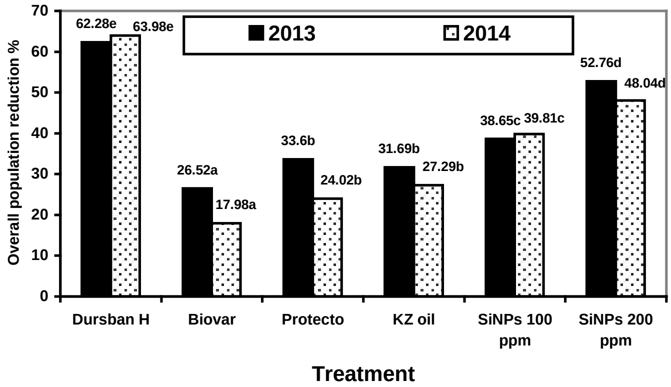

Fig. (1): Overall population reduction percentage of the pink bollworm, *Pectinophora gossypiella* numbers after treatments during the two seasons 2013 and 2014.

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

1.The effect on the spiny bollworm *Earis insulana* (Boisd.):

Data in Tables (4 and 5) show that, after two days from the first spray Dursban H was the most effective treatment to reduce the infestation with *E. insulana* (58.33%), followed by silica nanoparticles which recorded 40.48% reduction of infestation. After first spray (after 15 days) Dursban H and silica nanoparticles showed the highest effective compared with other treatments. Also, data showed the same trend in the second season.

Table (4): Reduction percentage of the spiny bollworm, *Earis insulana* as a result of use certain treatments during 2013 season at El-Riad region, Kafr El-Sheikh Governorate under field conditions.

Treatment	Rate/fed.	Treatment date	Population reduction %					
			2 days	5 days	7 days	10 days	15 days	Average
Dursban H	1 l	23 July	58.33	86.10	87.50	75.00	68.75	75.12
		11 Aug.	69.23	38.46	100.00	69.23	71.43	69.67
Biovar	800 ml	23 July	0.00	22.22	30.00	20.00	66.67	27.78
		11 Aug.	30.77	30.77	35.71	7.69	35.71	28.13
Protecto	300 g	23 July	2.78	25.93	33.33	33.33	44.44	27.96
		11 Aug.	42.31	53.85	35.71	30.77	57.14	43.96
KZ oil	2 l	23 July	16.67	53.70	66.67	66.67	72.22	55.19
		11 Aug.	30.77	53.85	57.14	53.85	57.14	50.55
Silica nanoparticles	100 ppm	23 July	28.57	60.32	71.43	78.57	52.38	58.25
		11 Aug.	53.85	42.31	67.86	65.39	67.86	59.45
	200 ppm	23 July	40.48	68.25	78.57	85.71	76.19	69.84
		11 Aug.	53.85	53.85	78.57	76.92	78.57	68.35

Table (5): Reduction percentage of the spiny bollworm, *Earis insulana* as a result of use certain treatments during 2014 season at El-Riad region, Kafr El-Sheikh Governorate under field conditions.

Treatment	Rate/fed.	Treatment date	Population reduction %					
			2 days	5 days	7 days	10 days	15 days	Average
Dursban H	1 l	23 July	40.00	71.43	87.50	88.89	81.88	73.94
		11 Aug.	31.25	38.89	50.00	100.00	50.00	54.028
Biovar	800 ml	23 July	0.00	14.29	12.50	22.22	27.27	15.256
		11 Aug.	31.25	38.89	25.00	8.33	0.00	20.694
Protecto	300 g	23 July	0.00	16.67	16.67	35.19	54.54	24.614
		11 Aug.	8.33	18.52	33.33	23.61	33.33	23.424
KZ oil	2 l	23 July	20.00	14.29	37.50	55.56	0.00	25.47
		11 Aug.	12.50	11.11	18.18	58.33	45.45	29.114
Silica nanoparticles	100 ppm	23 July	0.00	42.86	50.00	58.33	18.18	33.874
		11 Aug.	38.89	18.52	55.56	49.07	66.67	45.742
	200 ppm	23 July	16.67	52.35	47.92	62.96	62.12	48.404
		11 Aug.	45.00	26.67	80.00	26.67	60.00	47.668

Figure (2) shown Dursban H in two sprays/season was the highest effective recording 72.40 and 63.98% (average of two sprays) reduction of spiny bollworm, respectively. Silica nanoparticles (200 ppm) came in the second order recording 69.09 and 48.04% reduction, respectively during two successive cotton seasons, respectively. However, Biovar (*B. bassiana*) was the least effective, recording 27.95 and 17.98%, respectively. The efficiencies of tested compounds differed significantly.

The obtained results agree with those of Sharaf (2003), El-Basyouni (2003) and El-Ghobary (2011) they reported that chemical insecticide are considered the most efficient compounds to control *E. insulana*.

According to the effectiveness of silica nanoparticles Borei *et al.* (2014) and El-Samahy (2015) showed that one of the benefits of silica nanoparticles is its ability to stop pest feeding almost immediately after they feed on treated parts of the plant. Its unique mode of action ends the damage quickly, so crops are protected.

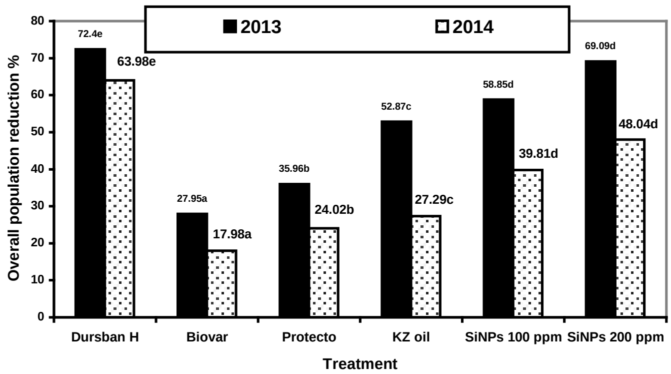

Fig. (2): Overall population reduction percentage of the spiny bollworm, *Earis insulana* numbers after treatments during two seasons.
Means followed by a common letter are not significantly different at the 5% level by DMRT

REFERENCES

Abd El-Mageed, A. E. M.; El-Gohary, A. L. R. A. and Dahi, H. F. (2007). Evaluation of several programs of sequences pesticides application on cotton bollworms and some other sucking pests in cotton field. J. Entomol., 4: 93-103.

Al-Shannaf, H. M. H. (2010). Effect of sequence control sprays on cotton bollworms and side effect on some sucking pests and their associated predators in cotton fields Egypt. Acad. J. biolog. Sci., 3 (1): 221 – 233.

Amin, A. A. and Gergis, M. F. (2006). Integrated management strategies for control of cotton key pests in middle Egypt. Agronomy Research 4(special issue), 121-128.

Borei, H. A.; El-Samahy, M. F. M. ; Galal, Ola A. and Thabet, A. F. (2014). The efficiency of silica nanoparticles in control cotton leafworm, *Spodoptera littoralis* Boisd. (Lepidoptera: Noctuidae) in soybean under laboratory conditions. Glob. J. Agric. Food Safety Sci., 2: 161 – 168.

Bramhankar, S. A. Nimbalkar, S. A. and Taley, Y. M. (1990). Potential of synthetic pyrethroids in alternation with conventional in control of bollworm complex of cotton. Indian J. Entomol., 52 (3): 456-460.

Duncan, D. B. (1955). Multiple Range and Multiple F. test. Biometrics, 11: 1-24.

El-Basyouni, S. A. (2003). Efficiency of some conventional insecticides on controlling the larvae or the bollworms. J. Agric. Sci. Mansoura Univ., 28 (3): 2363-2368.

El-Dessouki, S. A.; El-Khouly, A. S.; El-Zanan, A. A. and Somaa, H. M. (2006). Effect of some insecticides sequences against cotton bollworms larvae, non-target insects and associated predators in cotton fields. Egypt. J. Agric. Res., 84 (5): 1451-1458.

El-Ghobary, Asmaa M. A. (2011). Studies on some insect pests infesting cotton plants and their natural enemies at Kafr El-Sheikh Governorate. Ph. D. Thesis, Fac. Agric. Kafrelsheikh Univ., Egypt. Pp. 153.

El-Samahy, M. F. M. (2015). Compare the efficacy of sodium metasilicate with silica nanoparticles against *Spodoptera littoralis* (Boisd.) in the laboratory. Egypt. J. Agric. Res., 93 (1) (B): 553 – 560.

Epstein, E. and Bloom, A. J. (2005). Mineral Nutrition of Plants: Principles and Perspectives. Second Edition. Sinauer.

Hamza, M.; Maldonado, J. (2012). This report contains assessments of commodity and trade issues made by usda staff and not necessarily statements of official U. S. government policy. USDA foreign agricultural service.

Harper, S. L. (2010). New Approaches Needed to Gauge Safety of Nanotech-Based Pesticides, Researchers Urge. Published In Physics & Chemistry. 4(33):2010-2012.

Henderson, C. F. and E. W. Tilton (1955). Tests with acaricides against the brown wheat mite. J. Econ. Entomol., 48: 157 – 161.

Khidr, A. A.; Moawadi, G. M.; Desuky, W. M. H.; El-Sheakh, A. A. and Raslan, S. A. (1996). Effect of some synthetic pyrethroids on bollworms larvae in cotton field. Egypt J. Agric. Res., 74 (2): 321-332.

Matsumoto, S.; Christie, R. J.; Nishiyama, N.; Miyata, K. and Ishii, A. (2009). Environment-responsive block copolymer micelles with a disulfide cross-linked corefor enhanced siRNA delivery, Biomacromology, 10: 119-127.

Sharaf, F. H. (2003). Assessment the efficiency of certain different insecticides both spiny and pink bollworms on cotton crop. J. Agric. Sci., Mansoura Univ., 28 (3): 2369-2374.

Snyder, G. H.; Matichenkov, V. V. and Datnoff, L. E. (2007). Silicon. In Allen V, Barker, David J. Pilbeam (eds) Handbook of Plant Nutrition, CRC Press, pp 551-568.

كفـاءة السيليكا النانومتريـة مقارنـة مـع بعض المبيدات الحيويـة والزيـوت المعدنيـة ومبيد حشرى على ديدان اللوز تحت الظروف الحقليـة فى مركـز الريـاض بمحافظـة كفر الشيخ

أسماء محمد على الغبارى و مجدى فاروق محمد السماحى
معهد بحوث وقاية النباتات، محطة البحوث الزراعية بسخا، كفر الشيخ، مركز البحوث الزراعيـة، مصر

لقد أجريت هذه الدراسة فى مركز الرياض بمحافظة كفر الشيخ خلال موسمى 2013 و2014م لدراسة كفاءة السيليكا النانومترية فى مكافحة دودتى اللوز الشوكية والقرنفلية مقارنة ببعض المبيدات الحيوية والزيوت المعدنية والمبيد الكيماوى دورسبان.

أوضحت النتائج أن أفضل المواد المستخدمة لمكافحة دودتى اللوز الشوكية والقرنفلية هو المبيد الكيماوى دورسبان. تلاه استخدام السيليكا النانومترية بعد رشتين لكل منهما خلال موسمى الدراسة. كما أظهرت النتائج أن المبيد الفطرى بيوفلاى كان أقل المركبات المستخدمة كفاءة فى مكافحة الحشرتين محل الدراسة.