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An Experimental Study of Certain Neonicotinoid Insecticides on the Incidence of Early Infestation of the Spiny and the American Bollworms, Growth and Lint Yield Characteristics of Cotton Plants

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ABSTRACT

The cotton bollworms are major pests that reduce yield and quality of the growing cotton crop all over the world. The Spiny bollworm (SBW) *Earias insulana* (Boisd.) and American bollworm (ABW) *Helicoverpa armigera* (Hüb) are two common injurious bollworms of cotton in Egypt. A field experiment was conducted at Abo-Homos district, El-Behaira, Governorate during 2015 & 2016 cotton season to determine the efficacy of two neonicotinoid insecticides (imidacloprid and thiamethoxam) as seed dressing and seedling bed at the 3rd true leaf emergence of cotton plants (Giza 86). Reduction in the infestation and larval content/100 green bolls and/or plants of both pests was estimated through 30 - 90 days of germination. Furthermore, the total chlorophyll content, cotton yield and its fiber quality was determined. The results showed that imidacloprid and thiamethoxam caused a significant larval reduction (79.9, 75.5% & 66.9, 72.7%) of the SBW in both experimental seasons, respectively, at early infestation after 90 days of germination. In case of the ABW, thiamethoxam caused a gradual reduction (79.5, 70.8%) in both seasons, respectively. While, in imidacloprid treatment reduction was fluctuated (54.0 - 70.8%) after 90 days of germination in 2016 season. Most interestingly, the present results indicated that the application of imidacloprid and thiamethoxam as seed treatments significantly increased the total chlorophyll content in cotton leaves that enhance plant growth and improve cotton properties. In general, the selection of a suitable insecticide for controlling the cotton pests not only depends on its efficacy against the targeted insects but also on their profitable effects on cotton production and fiber quality.

Keywords: *Earias insulana* (Boisd.) , *Helicoverpa armigera* , neonicotinoid, chlorophyll, fiber quality, yield.

INTRODUCTION

Cotton is the most important commercial fiber crops in the world and considers a prominent place in the national economy. The cotton plant seems to be highly attractive to injurious insects i.e. the cotton leafworm, pink bollworm, spiny bollworm, the American bollworm, cotton aphid, cotton flea hoppers, grass hoppers, whiteflies and other insects for its variable characteristics (green succulent leaves, open flowers, nectarines on every leaf and flower and a large amount of fruits).

Spiny bollworm (SBW) *Earias insulana* (Boisd.) and the American bollworm(ABW) *Helicoverpa armigera* (Hüb) are two species of noctuid moths and consider the most destructive cotton insect pests in Egypt and middle eastern countries such as Syria, Turkey and Israel (Abo El-Nasr and Mabrouk 1973; El-Shaarawy *et al*. 1975; Stam and Elmosa 1990). SBW is primarily a mid- and late season insect-pest of cotton; it has no diapauses and has only restricted host range when compared with *H. armigera* which has a wide range of alternative host plants. Its larvae must feed on nectar anywhere on plant especially young shoots. Before flower buds are present larvae will enter the terminal bud and burrow inside the stem. This tip boring may cause seedling death. Also, it damage fruit buds and green bolls (Matthews, 1972). The reduction in cotton production caused by SBW species varied from 10 to 40% (Gahukar 2006). ABW larvae have been reported on more than 60 plants species belonging to 67 host families including Asteraceae, Fabaceae, Malvaceae, Poaceae and Solanaceae (Fitt 1989; Pogue 2004). Besides cotton, ABW can cause great losses to different economically important crops (Garcia, 2006). Because this pest has a high potential for spread and can cause economic damage to many crops, it has been reported as quarantine pest in many countries (EPPO 2017).

In Egypt, the ABW larvae feed on leaves and stems, although they prefer buds, inflorescences, fruits and pods (Reed 1965; Wang and Li 1984) causing damage in the vegetative and reproductive plant stages. According to (Nyambo, 1988), its larva can damage 10-12 fruiting branches during its life span. The attacked blooms may open prematurely and stay fruitless. Moreover, when the bolls are damaged, some of which will fall off and others will fail to produce lint or produce lint of an inferior quality. The annual worldwide costs for controlling this pest along with yield losses are estimated at US $ 5 billion (Lammers & Macleod 2013).Thus, great efforts have been made to improve the efficiency and specificity in insect control.Insecticides remain the most important element of integrated approaches in pest control. But unfortunately, insecticides used extensively tend to lose their effectiveness because of an increasing cycle of resistance. Lepidopteran, most notably cotton bollworms, had developed resistance to the major classes of insecticides, such as pyrethroids (Scott-Dupree *et al*. 2008; Achaleke and Brevault, 2010, Nada *et al*. 2011); carbamates (Kranthi *et al*. 2001; Torres-Vila *et al*. 2002); and organophosphates (Kranthi *et al*. 2001; Martin *et al*. 2003, Ren *et al*. 2002, Torres-Vila *et al*. 2002). Moreover, cotton bollworms did not only demonstrated resistance to the conventional pesticides but also showed resistance to *Bacillus thuringiensis* (Bt) transgenic cotton (Akhurst *et al*. 2003; An *et al*. 2015; Ibargutxi *et al*. 2006; Nair *et al*. 2010; Tabashnik *et al*. 2012). So far, no resistance to the neonicotinoids has been documented in this insect pest.

Imidacloprid and thiamethoxam are chloronicotinyl class of insecticides that are nicotinic analogue; a neurotoxin which binds to the nicotinic acetylcholine receptor (nAChR) of insects (Matsuda *et al*. 2001), causing hyper-excitation that eventually leads to the insect's death (Matsuda *et al*. 2005). Because of their systematic characteristic, they are applied against soil-living pests and seed as well as foliar treatments (Magalhaes *et al*. 2009; Lanka *et al*. 2013). In recent years, the use of systemic insecticide as seed treatments is considered one of the most effective compounds against sucking insects such as aphid, whiteflies, thrips and many coleopterans as well as some lepidopteran species (Yue *et al.* 2003; Ahmad *et al.* 2013; Ahmed 2014) . In general, seed treatments require much less active ingredient to control pests than traditional application methods, this will led to reduce exposure of the insecticide to the agriculture workers, environment and natural enemies (Nault *et al.* 2004; Younis *et al.* 2007). The effectiveness of imidacloprid and thiamethoxam applied separately, against the early stage insects on of cotton was studied by several authors (El-Zahi and Arif 2011; Zhang *et al.* 2011; El-Naggar and Zidan 2013).

In this concern, field experiments of imidacloprid and thiamethoxam as seed treatments against the Lepidopteran larvae of cotton bollworm in early infestation was poorly investigated (Abdel-wahab 2005). Moreover, only few data are available on the lethal and sub-lethal effects of insecticides belonging to neonicotinoids on the lepidopteran insects e.g. *Helicoverpa armigera* (Ahmad *et al.* 2013) and *Spodoptera littoralis* (Ahmed, 2014) under laboratory conditions; and *Ostrinia nubilalis* (Yue *et al.* 2003) under field conditions. That, emphasis the need of advanced research works to through more lights on the potential toxic effect of two insecticides belonging to neonicotinoids i.e., (imidacloprid and thiamethoxam) against two lepidopteran insect species under field conditions.

Therefore, the present study was experimented to assess the effectiveness of separately used imidacloprid and/or thiamethoxam, as cotton seed treatments to show its side effect against the Spiny bollworm (SBW) *Earias insulana* (Boisd.) and the American bollworm (ABW) *Helicoverpa armigera* (Hüb) infesting cotton(var.Giza 86) in Egypt. The infestation rate was determined along a period of 90 days post germination which is considered as a critical growth period of cotton plant development and boll formation. The growth, yield and the fiber quality of cotton plant were also determined.

MATERIALS AND METHODS

Experimental design

Two neonicotinoid insecticides were experimented against the most common bollworms-infested cotton in Egypt, SBW and ABW. A field experiment was conducted at Abo-homos district, El-Behaira, Government, Egypt, during the subsequent growing cotton season of 2015 and 2016. An area of about one feddan (feddan= 4200 square meter) was cultivated with cotton, *Gossypium barbadense*, (Giza 86) on the 15th April in both season and divided into three plots of equal parts . Each plot/ treatment/ implied three replicates as well as the control. The three replicates of each treatment were arranged in completely randomized blocks design. Starting from 20th June, samples of green bolls were randomly collected every ten days from the cotton cultivated area to determine the infestation rate of bollworms. Beginning from the 30th day of germination, the infestation of bollworms was inspected and recorded through external screening of 100 green bolls and/or plants/ treatment (developing peaks, flowers and buds).

The plant was externally and/or internally screened for assessing bollworms infestation once after the formation of the first square (50 days after germination).

Insecticides and seed treatment

1. **Imidacloprid:** (E) - 1 - (6-chloro -3- pyridylmethyl) - N-nitroimidazolidin -2- ylideneamine. The formulation of this insecticide (Gaucho 7% WS) was obtained from Bayer Co. It was applied as seed dressing treatment at 7 g/kg seeds.
2. **Thiamethoxam:** (EZ) – 3 - (2-chloro-1, 3-thiazol-5-ylmethyl) - 5-methyl - 1, 3, 5 -oxadiazinan-4-ylidene (nitro) amine. The formulation of this insecticide (Actara 25% WP) was obtained from Syngenta AG Co. It was applied as irrigation in seedling bed at 20mg/100-liter water after the emergence of the 3rd true leaf.

Total chlorophyll content

The mean of three registered readings by means of a portable chlorophyll meter SPAD-502 (Konica-Minolta, Japan) was calculated for each leaf disc of sampled individual leaves (10 leaves per plant) and pooled to obtain one SPAD measurement per disc. The leaf disc used to obtain a SPAD value provided sufficient tissue for total chlorophyll. Total chlorophyll content (nmol mg-1) of leaves was determined according to (Kariya *et al.* 1982).

Determination of cotton yield and fiber properties

The cotton yield was measured as the weight of lint (kg/plot); transformed to Kentar/feddan, (Kentar equal 50 kilograms of lint cotton). The USTER® HVI1000 system was used to measure the most important cotton fiber properties for cotton classing purposes in particular, moisture content, micronaire, maturity index, length, strength, color and trash.

Statistical analysis

The obtained data were analyzed by one-way analysis of variance using SPSS program (version 11.0; SPSS Inc. Chicago, IL, USA, 2011). The means were compared using the LSD test at $P < 0.05$.

RESULTS AND DISCUSSION

a) **Efficiency of applied imidacloprid and thiamethoxam seed treatments against the early bollworms infestation of cotton plants:**

The insecticidal activity of each of experimented imidacloprid and/or thiamethoxam as seed treatments against the two bollworms; SBW and ABW was evaluated under field conditions during the following seasons of 2015 and 2016. Data presented in Tables (1 and 2) summarize the extracted means number of cotton bollworm larvae/100 plant throughout 90 days after seeds germination. It is obvious that imidacloprid and thiamethoxam induced highly efficient delayed toxic effect against bollworms. The results related to the infestation time of both SBW and ABW indicate that the critical time of infestation occurrence usually begins after 50 days of germination for ABW and 60 days for SBW while the first infestation of SBW was observed after 70 days for imidacloprid and thiamethoxam in comparison to control in the 1st season 2015.In addition, the first infestation of SBW was observed after 70 days for imidacloprid and 80 days for thiamethoxam compared to the first infestation occurrence in control treatment, which was observed after 50 days of seed germination in the 2nd season, 2016 (Tables 1and 2).

Table 1. Insecticidal activity of imidacloprid and thiamethoxam applied as seed treatments against the early infestation of SBW&ABW on cotton plants (Giza 86) during the 2015 season.

Inspection (s) Time	Mean number (M.N.) ± SE of cotton bollworm larvae/100 green bolls or/and plants during the 90 days of germination											
	Earias insulana						*Helicoverpa armigera*					
	Control	Imidacloprid		Thiamethoxam		LSD	Control	Imidacloprid		Thiamethoxam		LSD
	M.N.	M.N.	%R	M.N.	%R		M.N.	M.N.	%R	M.N.	%R	
30 days	0.0±0.0	0.0±0.0	00	0.0±0.0	00	-	0.0±0.0	0.0±0.0	00	0.0±0.0	00	-
40 days	0.0±0.0	0.0±0.0	00	0.0±0.0	00	-	0.0±0.0	0.0±0.0	00	0.0±0.0	00	-
50 days	2.7±0.33a	0.0±0.0	100	0.0±0.0	100	0.67	3.3±0.33a	0.0±0.0	100	0.0±0.0	100	0.67
60 days	6.3±0.88a	0.0±0.0	100	0.0±0.0	100	1.76	10.0±0.58a	1.3±0.33	87.0	0.0±0.0	100	1.33
70 days	7.7±0.33a	1.3±0.33b	83.1	1.3±0.33b	83.1	1.16	14.7±0.88a	2.3±0.33b	84.3	2.7±0.33b	81.6	2.00
80 days	10.3±0.88a	2.0±0.0b	80.6	2.3±0.33b	77.7	1.89	17.0±0.58a	2.7±0.33b	84.1	3.0±0.0b	82.3	1.33
90 days	13.0±1.15a	3.0±0.58b	79.9	4.3±0.88b	66.9	3.12	21.0±0.58a	4.0±0.58b	80.9	4.3±0.33b	79.5	1.76

Mean number (M.N.) %R (Percent of Reduction) = [(M.N. in the control – M.N. in the treatment)/ M.N. in the control] x 100

The mean inside each row followed by the same letter do not differ from each other significantly from each other by the L.S.D at the 0.05 level

Table 2. Insecticidal activity of imidacloprid and thiamethoxam applied as seed treatments against the early infestation of SBW&ABW on cotton plants (Giza 86) during the 2016 season.

Inspection (s) Time	Mean number (M.N.) ± SE of cotton bollworm larvae/100 green bolls or/and plants during the 90 days of germination											
	Earias insulana						*Helicoverpa armigera*					
	Control	Imidacloprid		Thiamethoxam		$LSD_{0.05}$	Control	Imidacloprid		Thiamethoxam		$LSD_{0.05}$
	M.N.	M.N.	%R	M.N.	%R		M.N.	M.N.	%R	M.N.	%R	
30 days	0.0±0.0	0.0±0.0	00	0.0±0.0	00	-	0.0±0.0	0.0±0.0	00	0.0±0.0	00	-
40 days	0.0±0.0	0.0±0.0	00	0.0±0.0	00	-	0.0±0.0	0.0±0.0	00	0.0±0.0	00	-
50 days	3. 0±0.58a	0.0±0.0	100	0.0±0.0	100	1.15	2.7±0.33a	0.0±0.0	100	0.0±0.0	100	0.67
60 days	6. 0±0.58a	0.0±0.0	100	0.0±0.0	100	1.15	5.0±0.58a	2.3±0.33	54.0	1.0±0.33 b	80.0	1.33
70 days	7.7±0.88a	1.0±0.00b	87.0	0.0±0.0	100	1.76	10.3±0.88a	3. 7±0.33b	64.0	2.0±0.33b	80.5	2.33
80 days	10.0±0.88a	1.3±0.33b	87.0	1.3±0.33b	87.0	1.50	12.7±0.33a	4.0±0.58b	68.5	3.3±0.33b	74.0	1.15
90 days	11.3±0.67a	3.0±0.58b	75.5	3.3±0.33b	72.7	1.88	13.7±0.88a	4.0±0.58b	70.8	4.0±0.58b	70.8	2.40

Mean number (M.N.) %R (Percent of Reduction) = [(M.N. in the control – M.N. in the treatment)/ M.N. in the control] x 100

The mean inside each column followed by the same letter do not differ from each other significantly from each other by the L.S.D at the 0.05 level

On the other hand, the first infestation incidence of ABW was recorded after 60 days for imidacloprid and 70 days for thiamethoxam in the 1st season 2015 while in the 2nd one of 2016 the first infestation of ABW was observed after 60 and 70 days for both of tested imidacloprid and thiamethoxam respectively, compared to the recorded first infestation of control which occurred after 50 days of seed germination in the both seasons. It means that each of imidacloprid and thiamethoxam caused significant delay of probable incidence of the cotton bollworms infestations that ranged from 10 to 20 days. Moreover, the comparatively fewer calculated mean number of SBW and/or ABW for each treatment was significantly lower when compared to the respective control. Also, the obtained data showed that both the separately tested insecticides, exhibited a significant reduction in the means numbers of both inspected cotton bollworms. For SBW, imidacloprid caused a 100% initial reduction after 50 days of germination and impairment of non-significantly decreased to reach 79.9 and 75.5 % after 90 days post germination in both season respectively (Tables 1&2). Thiamethoxam showed also the same trend of results, where it induced a 100% initial reduction in the population after 50 days of treatment, and then gave non-significant decrease amounted to 66.9 and 72.7% after 90 days of germination in both seasons respectively (Tables 1 and 2). Regarding ABW, the exhibited data in Tables 1&2, also show that imidacloprid and thiamethoxam induced a significant reduction in the inspected number of infested plants by this insect. Reduction % infestation comprised 100.0 – 79.5 % and 100.0 – 70.8 % after 60 - 90 days of germination in 2015 & 2016 cotton season, respectively. In the other hand, imidacloprid induced gradual reduction ranged between 100.0 to 80.9% after 60 - 90 days of germination in 2015, In contrary, during 2016 season reduction% tumble to 54.0% after 60 days of germination then increased gradually to achieve 70.8 % after 90 days; anyhow the reduction value ranged between 100.0 to 70.8 % after 50 - 90 days of germination (Table 2).

Our obtained results clearly show that imidacloprid and thiamethoxam used separately as seed treatments gave highly effective protection against cotton bollworm larvae of early infestation. From these above cited results, it could be also noticed that imidacloprid had a slightly better toxic efficiency against both of inspected cotton bollworms than thiamethoxam, due to its highly systemic activity, especially through the root system. The obtained results were also in parallel with the pervious literary findings which showed that imidacloprid has a better efficiency against sap-sucking pests than thiamethoxam (El-sayed, 2013). Moreover, our exhibited results are in conformity with the previous carried out studies investigating the efficacy of imidacloprid as well as thiamethoxam on the larvae of European Corn Borer and Indian meal moth (Lepidoptera: Pyralidae). Yue, *et al*. (2003) found that all the fifth instar larvae of European corn borers died after 2 or 4 days of exposure to corn treated with 250 and 500 ppm, thiamethoxam. On the other hand, all second and third instars of Indian meal moth died after 5 days of exposure period to corn grain treated with imidacloprid or thiamethoxam at 50 ppm. this confirmed by Zhang *et al.* (2011) who provided that the cotton seeds treated with imidacloprid and thiamethoxam were effective against *B. tabaci* for up to 45 days under laboratory and greenhouse conditions, and up to 2 months under field conditions.

b) Effect of imidacloprid and thiamethoxam on chlorophyll content, growth and lint yield of cotton plant

The revealed effect of imidacloprid and thiamethoxam on the chlorophyll content of cotton plant is summarized in Table (3). The results showed a significant increasing trend in the chlorophyll content due to both performed treatments compared to the respective control. The higher calculated values of chlorophyll content comprised amounted to 44.5±1.21, 46.6±0.90 and 42.7±0.68, 42.2±0.52 nmol mg-1 for imidacloprid and thiamethoxam in both the following seasons of 2015 and 2016 respectively, whereas the estimated value in control, was lower and equaled (36.6 and 37.7) nmol mg-1. Thus, both treatments of imidacloprid and thiamethoxam more increased the photosynthesis levels and physiological of activity of cotton plant, which finally reflected on the chlorophyll content. The same performance was observed by many authors Gonias *et al.* (2006) in cotton Preetha and Stanley (2012) in cotton Baozhen *et al.* (2013) in maize and Huang *et al.* (2015) in oilseed rape. Preetha and Stanley (2012) provided that the neonicotinoid insecticides increased the soluble protein content of cotton and okra. this is reported to increase the ability of plants to fix carbon dioxide (CO_2) effectively and thus increase photosynthesis. Baozhen *et al.* (2013) showed that the increase of chlorophyll content in maize differently affected by imidacloprid at different application times, its content mostly increased by morning application, followed by noon, and least by afternoon application. Gonias *et al.* (2006) found that imidacloprid enhanced the metabolism of cotton plant, which was recorded as improved photosynthesis. Also, Huang *et al*. (2015) revealed that thiamethoxam treatment induced significant increase in the chlorophyll content in the leaf of oilseed rape when compared to control.

The best remarkable knowledge about our research article is the first throwing light on the influence of imidacloprid and thiamethoxam on square appearance in the cultivated cotton-variety (Giza 86), *Gossypium barbadens*e. The data presented in Table (3) illustrate that both imidacloprid and thiamethoxam reduced the elapsed period (per day) from planting to appearance of early square. The early detection of the square was observed after 50 days for both insecticides in both the following seasons, while in control treatment, the first appearance of square was recorded after 60.0& 58.3 days for both consequent seasons. Herein, it could be concluded that the application of each of imidacloprid and/or thiamethoxam as seed treatment promoted the early appearance of cotton squares.

The present study also showed that cotton seed treatments of imidacloprid and thiamethoxam had a significant positive effect on green and dry boll weights as well as the lint yield (Table 3). The green and dry boll weights were significantly increased by (17.6, 17.9g and 4.6, 4.6g) post imidacloprid treatment and by (18.1, 18.5g and 5.8, 5.3g) for thiamethoxam, compared to (13.9, 13.5g and 3.1, 3.2g) in the untreated control in both seasons, respectively. The same trend of results had been detected for both insecticides on the measured lint yield in both seasons, where, the lint yield was merely equally increased by (8.5 - 8.7) kentar/feddan for both insecticides in the two subsequent seasons , compared to the untreated control plants that gave lint yield of (5.6 – 5.8) kentar/feddan only. The statistical analysis of data revealed the insignificant differences between imidacloprid and thiamethoxam. The present results are in agreement with that findings reported by Gonias *et al.* (2006) who studied the effect of imidacloprid on cotton growth and yield enhancement after foliar application in the absence of insects. They reported that imidacloprid increased lint yield, dry matter production as well as crop growth.

c) The impact of imidacloprid and thiamethoxam on cotton fiber quality

Data presented in Table (4) show the effect of imidacloprid and thiamethoxam on cotton fiber quality in the both seasons of 2015 and 2016. The results revealed that both applied insecticides significantly increased the examined cotton fiber properties compared to the untreated control. No significant differences were observed in fiber finesses (micronaire reading) as affected by both compounds in season 2016. Whereas, the highest value of micronaire reading (4.98, 4.92 micronaire unit) resulted post thiamethoxam followed that of imidacloprid which comprised (4.36, 4.98 micronaire unit) in both the subsequent seasons, respectively, while the lowest value of (3.14 micronaire unit) was found in the untreated control. It is clearly obvious that imidacloprid and thiamethoxam applications could improve the micronaire factor. Our results are coincide with those mentioned by Mohamed (2013) who observed that higher micronaire value was obtained in case of treatment with imidacloprid and acetamiprid for controlling cotton bollworms and Jassid insect. Also, maturity index was affected by both the tested insecticides, which gave value of maturity index comprising (0.84 - 0.89 index) compared to control (0.60 index). In regards to the measurements of fiber length, the results indicated that there were no significant differences in all performed measurements except the detected values of uniformity index which showed an interaction significant difference between thiamethoxam (85.2%), imidacloprid (84.8%) and control (83.6%) in the 2nd season 2016, Table (4), versus the insignificant observed difference between both insecticides and control in the 1st season 2015, Table (4). Moreover, our data showed that the determined values of fiber strength in both treatments did not significantly differ from that of the untreated control Table (4). The obtained results are in harmony with (Gonias *et al.* 2008) who reported that foliar application of imidacloprid enhanced growth and yield of cotton. Also, fiber quality properties did not significantly differ from that of the untreated control.

Table 3. Effect of imidacloprid and thiamethoxam on the chlorophyll content, growth and lint yield during 2015 and 2016 cotton seasons.

Insecticides	SPDA Chlorophyll content (nmol mg-1)	Nitrogen %	First square (day)	Green boll weight (g)	Dray boll weight (g)	Lint yield/Feddan (kentar)
			Season 2015			
Imidacloprid	44.5±1.21 a	4.6±0.40 *b*	50.0±0.00	17.6±0.61*a*	4.6±0.35 b	8.5±0.14*a*
Thiamethoxam	42.7±0.68 a	4.7±0.21 *b*	50.0±0.00	18.1±0.62 *a*	5.8±0.06 *a*	8.6±0.09 *a*
Control	36.6±0.41 b	5.7±0.37 *a*	60.0±0.00	13.9±0.35 b	3.1±0.21*c*	5.6±0.32b
LSD 0.05	2.89	0.68	-	1.87	0.82	0.72
			Season 2016			
Imidacloprid	46.6±0.90a	4.1±0.18 c	50.0±0.00	17.9±0.35 a	4.6±0.31 a	8.5±0.29 a
Thiamethoxam	42.2±0.52 a	4.9±0.09 b	50.0±0.00	18.5±0.42 a	5.3±0.33 a	8.7±0.06 a
Control	37.7±1.52 b	5.7±0.46 a	58.3±0.00	13.5±0.81b	3.2±0.15 b	5.8±0.06 b
LSD 0.05	3.68	0.66	-	1.29	0.95	0.60

The Mean inside each row followed by the same letter do not differ from each other significantly from each other by the L.S.D at the 0.05.

The Mean inside each row followed by the same letter do not differ from each other significantly from each other by the L.S.D at the 0.05 level Nitrogen%=12.564-(0.182xSPDA).

Table 4. Effect of imidacloprid and thiamethoxam applications on fiber quality properties during 2015 and 2016 cotton seasons.

Insecticides	Micronaire	Maturity index	Length		Strength	
			Uniformity index %	Short fiber index %	Fiber strength (g/tex)	Elongation
			Season 2015			
imidacloprid	4.36±0.07*b*	0.84±0.00 *a*	84.7±1.07	7.3±0.44 *b*	36.1±1.91	6.63±0.18 *a*
thiamethoxam	4.98±0.09 *a*	0.89±0.06 a	84.8±0.58	7.2±0.26 b	40.0±0.23	5.46±0.23 *c*
Control	3.14±0.06 b	0.60±0.00 b	83.6±0.35	7.9±0.21 a	38.6±1.93	6.03±0.15 b
LSD 0.05	0.53	0.24	2.54	0.09	5.43	0.54
			Season 2016			
Imidacloprid	4.98±0.05a	0.89±0.00 a	84.8±0.58 a	7.16±0.26	40.03±0.23	5.5±0.13 b
Thiamethoxam	4.92±0.09 a	0.89±0.06 a	85.2±0.38 a	7.23±0.23	41.10±0.95	6.0±0.37 a
Control	3.14±0.06 b	0.60±0.00 b	83.6±0.35ab	7.90±0.21	38.66±1.92	6.0±0.15 a
LSD 0.05	0.25	0.02	1.55	0.81	4.32	0.24

The Mean inside each column followed by the same letter do not differ significantly from each other by the L.S.D at the 0.05

Finally, it could be concluded that both of the tested imidacloprid and thiamethoxam as a seed treatment, are promising candidate compounds that could be used successfully to protect and reduce the cotton bollworm infestation in cotton, improve growth and increase lint yield. Moreover, further studies are needed to understand the impact of these insecticides on the behavioral and physiological changes of cotton bollworm larvae.

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دراسة تجريبية علي معاملة القطن بمركبات النيونكتونويد ضد الاصابة المبكرة لدودة اللوز الشوكية والأمريكية وتأثيرها علي النمو وخصائص المحصول

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تعتبر ديدان اللوز أكثرالآفات خطورة على محصول القطن حيث تقلل من إنتاجيته وجودته. أجريت الدراسة الحقلية على مدى موسمين متتالين لأختبار تأثير كلاً من مركب (الأميداكلوبرايد، والثيوميسوكسام) من مجموعة النيونكتينويد كمبيدات تربة و بذرة ضد ديدان اللوز الشوكية و الأمريكية فى حقول القطن بمصر خلال ٩٠ يوم الأول من عمر نبات القطن. وكذلك دراسة وتقيم محتوى الكلورفيل الكلى فى أوراق محصول القطن، الإنتاجية، جودة التيلة (الألياف). وقد أوضحت النتائج أن المعاملة بكلاً من الأميداكيلوبرايد والثيوميسوكسام أخفضت الإصابة بديدان اللوز الشوكية (٧٩,٩، ٧٥,٥% و ٦٦,٩، ٧٢,٧%) فى الموسمين على التوالى خلال ٩٠ يوم الأولى من عمر النبات. بينما كانت نسبة الإصابة (٨٠,٩،٧٠,٨% و ٧٩,٥، ٧٠,٨) فى ديدان اللوز الأمريكية فى كلاً من الموسمين على التوالى خلال ٩٠ يوم الأولى من عمر النبات. ولقد أوضحت النتائج أيضا وبشكل مثير للأنتباه أن المعاملة بكلاً من المركبين الأميداكلوبرايد و الثيوميسوكسام أعطت زيادة معنوية فى المحتوى الكلي للكلورفيل لأوراق القطن وتحسين نمو النبات والمحصول بصفة عامة وكذلك أعطت المعاملة بكلاً من المركبين ظهور مبكراً لأفرع الثمرية واللوز الوسواس، وحسنت من صفات التيلة. وعموماً فإن إختيار المبيد المناسب ضد ديدان اللوز لايعتمد فقط على التأثير على الآفة ولكن لابد أن نأخذ فى الأعتبار صحه النبات، الأنتاجية و جودة التيلة (الألياف).