Residual and biochemical effects of novel insecticides on *Spodoptera littoralis* (Boisd) and their impact on chlorophyll content in sugar beet leaves.

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Abstract: The present study was conducted during season 2013 to evaluate the residual effect of Runner®(methoxyfenozide), Tracer®(spinosad), PteraNill® (fibronil) and Safe oil® (azadirachtin) against the fourth instar larvae of *Spodoptera littoralis* (Biosd) after sequenced interval periods of 7 days from the treatment under the laboratory conditions. The biochemical changes of the concentrations of some inorganic elements in the insect haemolymph were determined. The side effects of the tested insecticides on the chlorophyll content in plant leaves were taken in consideration.

The highly residual effect was occurred by methoxyfenozide that achieved 100% mortality after four days from application followed by spinosad, fipronil and azadirachtin, respectively. There were no significant differences after 7 days from application found between the efficacies of methoxyfenozide or spinosad alone (100 and 95.00%) and their combinations with azadirachtin (100 and 96.66%), respectively.

The obtained results illustrated that manganese and copper ions in haemnolymph were not affected significantly with all treatments. Among all treatments, the most effective treatments in reducing all inorganic ions levels were methoxyfenozide and spinosad. However, azadirachtin and fipronil reduced only calcium and potassium levels but increased sodium concentration in the haemolymph.

It could be concluded that the most effective insecticides (methoxyfenozide and spinosad) against the 4th instar larvae indicated the highest concentration reductions of inorganic constituents in the larval haemolymph especially calcium, sodium and potassium. Therefore, more attention must be directed towards the inorganic constituents in the larval haemolymph as biomarkers for insecticides efficacy.

Regarding the effect on chlorophyll content in sugar beet leaves, azadirachtin increased significantly the chlorophyll content in leaves but spinosad decreased it.

Keywords: Insecticides, *Spodoptera littoralis*, Sugar beet, biochemical, chlorophyll

1. Introduction

The importance of sugar beet, *Beta vulgaris* L. (Family: Chenopodiacea) is not only to produce sugar, but also to use it's by products in feeding animals due to the high nutritive value of sugar beet leaves. The sugar beet has a higher sugar concentration (13 - 18%) compared to 10% sugar concentration in cane, and lower water consumption. Beet is planted in the Delta area in August and September and harvested in March **(USDA, 2013)**.

In Egypt before 1982, sugar beet had been considered the second important sugar crop after sugarcane. The area under cultivation had been estimated by 16.000 feddan that participated in 2.5 % of the total production of sugar. However, in 2013 the cultivated area increased up to 423.000 feddan with sugar production of 53.10 %. Therefore, Sugar beet crop became the first source of sugar production in Egypt **(El-shafei, 2014)**. There is a gap between consumption and production of sugar of 5000 tons **(Afifi, 2001).** Thus, increasing the area and yield of sugar beet were important goals of the ministry of agriculture.

However, the average yield of sugar beet was 20.3 tons /feddan that could be increased up to 40 tons / Fed. It is well known that the high yield of any crop is the final goal. Pests' infestation is the main limiting factor, which affect the yield quantitatively as well as qualitatively.

Sugar beet plants attract more than 150 insect species and mites. Out of them, 40-50 insect species cause economic damage **(Zarif and Hegazi, 1990)**. So, many investigators were attracted to study a group of insect pests that cause serious problems for growers and cause yield reductions

(Bassyouny and Khalafalla, 1996, Ebieda, 1997 and 1998 and Ebieda *et al*., 1998).

The cotton leaf worm, *Spodoptera littoralis* (Boisd) is one of the most destructive agricultural lepidopterous pests within its subtropical and tropical range. The pest causes a variety of damage as a leaf feeder and sometimes as a cut worm on seedlings. *Spodoptera littoralis* is a key polyphagous pest in Egypt. It is the most destructive insect pest of great variation of important vegetables and field crops. It can attack numerous economically important crops throughout the year **(EPPO, 1997)**.

On most crops, damage arises from extensive feeding by larvae, leading to complete stripping of the plants. In Egypt, the insect is one of the most destructive pests of cotton which is considered the most valuable crop in the country. Over the past 25 years, the intensive use of broad-spectrum insecticides against *S. littoralis* has led the development of insect resistance to many registered pesticides **(Aydin and Gurkan 2006)**.

In this scenario, using new types of insecticides, originated from natural agents or products that disrupt the physiological processes of the target pest, could be useful alternatives in the integrated management approach **(Dhadialla *et al*. 1998; Thompson *et al*. 2000 and Smagghe *et al*. 2003)**.

So, the present study aimed to: a) evaluate the residual toxicity against cotton worm larvae of certain recent pesticides to show what extent they might be included in an IPM program of sugar beet; b) determine the biochemical changes of the concentrations of some inorganic elements in the haemolymph of *Spodoptera littoralis* larvae as indicators for insecticides toxicity; c) estimate the side effects of the tested insecticides on the chlorophyll content in plant leaves.

2. Materials and methods

Field trials were conducted by cultivating sugar beet (*Beta vulgaris* L.,) variety MK2135 (multi-germ) supplied by the Sugar Crops Research Institute (SCRI), Agricultural Research Center (ARC) during season 2013 at the Sugar Cane Research Station, Sabahia Station, Alexandria, Egypt.

The experimental area was divided into 6 plots: each treatment was 175 m^2. The Plants were grown at spacing within hills as 25cm and in accordance with the normal agricultural practices and recommendation guidance.

Semi field trail was conducted to determine the residual efficacy of certain novel insecticides on *Spodoptera littoralis* (Boisd), where the sugar beet plants were sprayed with the tested insecticides used individually as well as in mixtures with a formulated neem insecticide in the field. Leaves were collected randomly after one hour of spray and transferred to laboratory to feed the 4^{th} instars of *S. littoralis*.

Treatments included 5insecticides plus an untreated check control. Insecticides were applied using a knapsack sprayer (20 L) at the rate of 200 Liters / Feddan, to give a complete coverage of all plants. The insecticides were used individually according to their recommended field rates. The same treatments were repeated with the combination between the half recommended doses of Safe oil with the half dose of each other insecticides. Each treatment has one plot in filed ($175m^2$). Two rows were used as a barrier between each treatment and the others. Treatments were arranged in a complete randomized design. Leaves Samples were taken from field and then transferred to laboratory to feed the cotton leaf worm larvae. Five replicates were used and each replicate was represented by 20 larvae of the 4^{th} instar. The treated larvae were inspected out at periods of 1, 2,3,4,5,6 and 7 days post treatment. The degree of mortality values were estimated according to Abbot Formula1925:

Mortality %= y-x/x *100

Where:

y % survivorship in the experimental group

x % survivorship in the control group (concentration of pesticide)

Table1: Pesticides and their application rates during growing season of 2013.

Trade name	Formulation	Common name	Recommend-ed dose Rate/ 1 L water	Manufacture Company
Safe oil	0.03% EC	azadirachtin	5ml / L	T &Stans Co.
Tracer	24% SC	spinosad	0.35 ml/L	Dow Agro Sciences
Runner	24% SC	methoxyfenozide	0.75 ml /L	Dow Agro Sciences
Ptera Nill	2.5% EC	fipronil	3 ml /L	Advance and Agrochemicals and Veterinary Product Co.

A- Chlorophyll content of sugar beet leaves was *spectrophotometrically* determined according to the described method by **Yadava (1986)**. The total chlorophyll pigment was determined in the leaves of sugar beet plants by the Minolta chlorophyll meter (model SPAD 502) where the value measured by the chlorophyll present in the plant leaf. The calculated values are based on the amount of light transmitted by the leaf in two wave length regions in which the absorbance of chlorophyll is different. It is a compact meter designed to help users to improve crop quality and increase crop yield by providing an indication of the amount of chlorophyll present in plant leaves.

B- Haemolymph collection to determine elements :
After 24hrs from the application of insecticides, the haemolymph was collected in a pre-chilled test tube containing a few crystals of thiourea by cutting the first proleg of the 4th larval instar. The haemolymph was centrifuged at 3000 g for 10 min at 4^oC and the supernatant was used in the metal ion determination.

2.1. Determination of inorganic ions*:*

One ml of the collected haemolymph of each treatment was digested by using, 10 ml of acid mixture; 9:4 (nitric acid and perchloric acid respectively) using digestion chamber (Digester 1009) until a clear solution was obtained. The solution was then cooled and the volume was made up to 20ml with redistilled water. The solution was filtered through Whatman No.1filter paper. The cations were determined from the aliquots of filtrate. Traces of metal ions (calcium, Iron, copper, manganese and zinc) were determined using atomic absorption spectrophotometer (GBC 932 Plus).

Data were subjected to the analysis of variance via Randomized Complete Block Design (F test). The least significant difference (LSD) at the 5% probability level was applied according to computer program Costat and Duncan's Multiple Range testes modified by **Steel and Torrie (1981)** to compare the average numbers of inspected pest infestations.

3. Results and Discussions

3.1. Effect of the tested pesticides on the mortality percentage of the 4th instar larvae

3.1.1. Effect of the recommended doses:

The results shown in table (2) revealed the effect of the recommended dose of pesticides on the mortality percentage of the 4th instar of *S. littoralis*. The highly residual effect was occurred by methoxyfenozide that achieved 100% mortality after four days from application followed by spinosad, fipronil and azadirachtin giving 76.66, 68.33 and 31.66%, respectively. However, after 7 days from application, methoxyfenozide and fipronil were equal in inducing the highest mortality percentage of 100%. However, the least determined mortality after 7 days was observed by azadirachtin (53.33%)

3.1.2. Effect of the mixtures:

The obtained results in table (2) show the effect of combinations between the half dose of three tested pesticides and the half dose of Safe oil (azadirachtin) on the 4th instar of *Spodoptera littoralis*. The highest mortality percentage (100%) was occurred by the mixture of Safe oil (azadirachtin)+ Runner (methoxyfenozide) after 4 days of application. Moreover, the mixture of azadirachtin with methoxyfenozide gave 100% followed by the mixture with spinosad that gave 96.66% mortality after 7 days from application. However, the least mortality (75.00%) was observed by mixing azadirachtin with fipronil.

According to the obtained results, it could be concluded that there were no significant differences between the efficacies of methoxyfenozide or spinosad alone (100 and 95.00%) and their half doses with azadirachtin (100 and 96.66%), respectively after 7 days from application.

Table 2: Residual effect of the tested pesticides and their combinations on the 4th instar larvae of *S.littoralis*.

Treatments	Mortality % after interval days						
	1 day	2 days	3 days	4 days	5 days	6 days	7 days
azadirachtin	0.00^{b} ±0.0	10.00^{b} ±2.35	30.00^{bc} ±4.71	31.66^{de} ±3.60	41.66b ±3.60	50.00c ±2.35	53.33^{c} ±3.60
spinosad	26.66^{a} ±9.81	40.00^{a} ±6.23	71.66^{a} ±8.92	76.66^{b} ±6.80	83.33^{a} ±5.44	90.00^{a} ±4.08	95.00^{a} ±4.08
Methoxyfen-ozide	1.66^{b} ±1.36	31.66^{a} ±3.60	66.66 ^{a} ±7.20	100.00^{a} ±0.00	100.00^{a} ±0.00	100.00^{a} ±0.00	100.00^{a} ±0.00
fipronil	0.00^{b} ±0.00	1.66^{b} ±1.36	26.66^{bc} ±5.93	68.33^{bc} ±3.60	83.33^{a} ±3.60	90.00^{a} ±2.35	100.00 ^{a} ±0.00
azadirachtin + spinosad	0.00^{b} ±0.0	8.33^{b} ±4.90	40.00^{b} ±8.49	50^{cd} ±8.49	85.30^{a} ±12.24	95.00^{a} ±4.08	96.66^{a} ±2.72
azadirachtin + methoxyfen-ozide	0.00^{b} ±0.00	1.66^{b} ±1.36	70.00^{a} ±6.23	100.00^{a} ±0.00	100.00^{a} ±0.00	100.00^{a} ±0.00	100.00^{a} ±0.00
azadirachtin + fipronil	0.00^{b} ±0.00	1.66^{b} ±1.36	10 ^{cd} ±4.71	28.33^{e} ±8.27	56.66^{b} ±7.20	66.66^{b} ±8.92	75.00^{b} ±8.16
Control	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{d} ±0.00	0.00^{f} ±0.00	0.00^{c} ±0.00	0.00^{d} ±0.00	0.00^{d} ±0.00
LSD .05	**12.86**	**12.11**	**23.30**	**18.94**	**20.82**	**14.46**	**13.21**

The same letters indicated in each column mean that the means are not significant at L.S.D $_{0.05}$

These results are in agreement with those of **Hamouda and Dahi (2008)** who indicated that spinetoram is a fairly toxic with LC_{50} (1.11 ppm) when tested against the 4th instar of *S. littoralis.* While, **Elbark *et al.* (2008)** reported that the LC_{50} of the 2nd and 4th larval instars of *S. littoralis* treated with radiant after 24hour were 0.05 and 6.67 ppm, respectively. Also, **Hassan (2009)** estimated the LC_{50} of spinetoram on the second instar larvae of *S. littoralis* after 48hour which ranged from 0.022 to 0.033ppm while it ranged from 1.78 to 2.64ppm of the 4thinstar.Also, Tracer has been shown to be an effective pest control agent (Brickle *et al*., 2001), particularly for control of lepidopteran insect pests **(Wanner *et al*., 2000)**.

Zarate *et al.* (2010) found that the combination of lethal and sublethal effects of methoxyfenozidemay have important implications for the population dynamics of the fall armyworm. Whereas, the previous studies demonstrated that the ecdysone agonist insecticide (methoxyfenozide) can cause progressive larval mortality in subsequent in stars of the treated insects. These studies also suggested that the chemicals may cause several sub lethal effects, such as weight loss in larvae and deformation, in both the pupal and adult stages of surviving individuals. In this study, *S.frugiperda* larvae treated with methoxyfenozide from the fifth instar until pupation showed also feeding cessation and morphological changes such as double head capsule formation, extrusion of the hindgut, and incapability for shedding the old cuticle. In addition, Pineda *et. al.*,2007 found that a progressive larval mortality was observed in subsequent instars when early instars of *Spodoptera littoralis* (Boisd) were treated with methoxyfenozide.

In all these cases molt induction had lethal consequences. The morphological abnormalities occurred because the induction of a rapid molt did not provide enough time for the completion of larval-pupal transformation. Since fipronil is a broad-use insecticide that belongs to the phenylpyrazole chemical family, **Sakr (2007)** found that the 5-aminopyrazolo-pyrazolone caused arrest or/and disruption of metamorphosis. Such metamorphic disruption induced a non-viable larva-pupa intermediates that died within 24 h. The 5-aminopyrazolo-pyrazolone was found to be more potent than the 3-pyrazolo-acrylate.

Martinez *et al*. (2001) found that azadirachtin showed promising for the control of the species not only for causing mortality failure but also for disrupting the development and for causing deformities involved in vital activities like feeding, walking or flying, making the insect vulnerable to several sorts of mortality agents or prevent them from causing damage to the crop.

3.2. Effect of the tested insecticides on the concentration of inorganic constituents in haemolymph:

The knowledge of the changes of the inorganic elements concentrations in the insect haemolymph especially Na^+, K^+, Ca^{++} and Mg^{++} is important for studying osmoregulation and functions of muscles and nerves. The concentrations of some cations in the haemolymph were estimated for those larvae that feeding on the leaves that treated with insecticides in the field and compared with the untreated larvae.

Determinations of the concentrations of six inorganic elements are presented in Table 4. Among these determined elements in the haemolymph of the untreated larvae, calcium (Ca^{++}) was found to represent the highest concentration followed by potassium (K^+) and sodium (Na^+) cations, while Mn, Cu and Fe were the least ones. As a fact, the high potassium level was characteristic of phytophagous insects **(Wiggelsworth, 1972)**. The obtained results are in agreement with those obtained by **El-Shafei*et al*. (1987)** who found that K^+ was the major cation in all active and diapause phase of the pink bollworm *P. gossypiella* (Lepidoptera).

3.2.1. Haemolymph calcium concentration:

The inorganic constituents such as Na^+, K^+, Ca^{++} are of vital importance in view of their role in the neurophysiology of the insect and their levels inside and outside the nerve membrane and they have to maintained for the propagation of impulses **(Roeder, 1953)**.

In general, calcium levels in the haemolymph of the 4th instar treated larvae were lower than the untreated (Table, 3). Among the single insecticide applications, the highest significant reduction of calcium was observed in methoxyfenozide (116.40 mg/l) followed by fipronil (122.20 mg/l), spinosad (162.20 mg/l**)** and azadirachtin (179.80 mg/l) compared with the untreated check (191.6 mg/l).

Referring to the mixtures of azadirachtin with the other insecticides, the mixture with spinosad significantly reduced Ca^{++} followed by with fipronil and methoxyfenozide giving 124.00, 132.8 and 152.2 mg/l, consequently.

These results are in agreement with those of **Salamab *et al*. (1994)** who found that treated larvae of *P. operculella*with *B. thuringiensis* showed some reduction of calcium and magnesium ions but there was no obvious change in the level of zinc ions. A slight decrease in sodium and obvious increase in potassium and manganese ions occurred.

3.2.2. Haemolymph iron concentration:

Iron concentrations in haemolymph of the treated 4thlarval instars are showed in Table (3). A significant drop in the iron levels was observed after treatments. The detected iron concentration in haemolymph of the untreated larvae reported 1.589 mg/l. It is worth to mention that the iron concentrations in haemolymph were increased by the treatment of azadirachtin (1.833 mg/l) and fipronil (2.041 mg/l) as well as by their combination (3.85 mg/l). On the other hand, the iron concentration was decreased in the treatment of methoxyfenozide(0.2378 mg/l) and spinosad(0.768)and their mixture with azadirachtin (1.01 mg/l and 1.298 mg/l, respectively)

Iron must be absorbed from the diet into gut cells, from the apical to the basal membrane of the gut epithelium, and then transferred to the haemolymph. Iron must be acquired to provide catalysis for oxidative metabolism, but it must be controlled to avoid destructive oxidative reactions **Nicole *et al*. (2002)**. Obtained results which are in cope with those obtained by **Kordy (2005)** who found that the concentrations of the all detected inorganic elements in those larvae treated with Biofly1 and lufenuron were less than those concentration determined in the control larvae.

3.2.3. Haemolymph manganese concentration:

The haemolymph manganese levels were detected in the haemolymp of the treated larvae with pesticides (Table, 3).There were no significant differences of manganese in haemolymph collected from all treated and the untreated larvae. Nevertheless, the copper concentrations were decreased, insignificantly, in larvae treated with methoxyfenozide (0.1513 mg /l), spinosad (0.2151 mg/l) and azadirachtin (0.3511 mg/l) than that in untreated larvae (0.662 mg/l). Also, Mn levels were decreased in case of the mixtures of azadirachtin with methoxyfenozide (0.3221 mg

/l), spinosad (0.438 mg/l) and fipronil (0.5233 mg/l). Slightly increase was observed in case of fipronil (0.9666 mg/l).

3.2.4.Haemolymph copper concentration:

The determined copper concentrations in larval haemolymph in revealed that there were no significant differences of Cu between treated or not treated ones (Table, 3). Meanwhile, a considerable decease was detected in the haemolymph collected from larvae treated methxyfenozide (0.3941 mg/l) when compared with that in the untreated larvae (0.869 mg/l).

3.2.5. Haemolymph potassium concentration:

As seen in table (3), highly clear significant differences of potassium concentrations in the haemolymph were observed between untreated and all treated larvae. The potassium values significantly declined in the single treatments of methoxyfenozide, spinosad, azadirachtin and fipronil inducing 27.38, 46.43, 69.83 and 105.8 mg/l, consequently. Moreover, all used mixtures significantly decreased the potassium concentration especially the mixture of azadirachtin with methoxyfenozide giving only 16.16 mg/l.

3.2.6. Haemolymph sodium concentration:

The obtained results in Table (3) showed that there are varied significant differences in the haemolymph sodium resulted from all treatments compared with the untreated check. A significant decrease was noticed in the treatment of methoxyfenozide (59.12mg/l) or spinosad (62.66 mg/l) versus the untreated check (84.17). With a counterproductive way, Na^+ in haemolymph was significantly increased by the treatment of azadirachtin and fipronil indicating 11.90 and 163.0 mg/l, successively. Again, all used mixture indicated a significant decrease of Na^+ in larval haemolymph.

Accordingly, from the previous results it could be concluded that manganese and copper ions in haemolymph were not affected significantly with all treatments. Among all treatments, the most effective treatments in reducing all inorganic ions levels were methoxyfenozide and spinosad. Azadirachtin and fipronil reduced only calcium and potassium levels but increased sodium concentration in the haemolymph.

With reference to the results of the efficacy of the tested insecticides, the most effective insecticides (methoxyfenozide and spinosad) against the 4^{th} instar larvae indicated the highest concentration reductions of inorganic constituents in the larval haemolymph especially calcium, sodium and potassium. Therefore, more attention must be directed towards the inorganic constituents in the larval haemolymph as biomarkers for insecticides efficacy.

Table 3: Effect of the pesticides on the haemolymph captions concentration of *S. littoralis* larvae after 24 hours from application.

Treatments	Haemolymph metal ion (mg/l)					
	Calcium	Iron	Mang-anese	Copper	Potassium	Sodium
azadirachtin	179.80^{b} ±0.47	1.8331^{b} ±0.47	0.3511^{a} ±0.47	0.9917^{a} ±0.47	69.83^{d} ±0.47	112.90^{b} ±0.47
spinosad	162.20^{c} ±0.47	0.768^{bc} ±0.47	0.2151^{a} ±0.47	0.8026^{a} ±0.47	46.43^{f} ±0.47	62.66^{g} ±0.47
Methoxyfen-ozide	116.40^{h} ±0.47	0.2378^{c} ±0.47	0.1513^{a} ±0.47	0.3941^{a} ±0.47	27.38^{g} ±0.47	59.12^{h} ±0.47
fipronil	122.20^{g} ±0.47	2.041^{b} ±0.47	0.9666^{a} ±0.47	0.847^{a} ±0.47	105.8^{b} ±0.475	163^{a} ±0.47
azadirachtin + spinosad	124.00^{f} ±0.47	1.298^{bc} ±0.47	0.438^{a} ±0.47	0.75^{a} ±0.47	103.4^{c} ±0.47	67.29^{f} ±0.47
azadirachtin + methoxyfenozi-de	152.2^{d} ±0.47	1.017^{bc} ±0.475	0.3221^{a} ±0.475	0.4854^{a} ±0.471	16.61^{h} ±0.47	75.26^{d} ±0.47
azadirachtin + fipronil	132.8^{e} ±0.47	3.85^{a} ±0.47	0.5233^{a} ±0.47	1.073^{a} ±0.47	65.04^{e} ±0.47	69.66^{e} ±0.47
Control	191.6^{a} ±0.47	1.589^{bc} ±0.47	0.662^{a} ±0.47	0.869^{a} ±0.47	111.6^{a} ±0.47	84.17^{c} ±0.47
LSD .05	1.73	1.73	1.73	1.73	1.73	1.73

The same letters indicated in each column mean that the means are not significant at L.S.D $_{0.05}$

3.2.7. Effect of tested pesticides on chlorophyll content of the sugar beet after 24h of applications.

Chlorophylls are greenish pigments which contain a porphyrin ring. This is a stable ring-shaped molecule around which electrons are free to migrate. Because the electrons move freely, the ring has the potential to gain or lose electrons easily, and thus the potential to provide energized electrons to other molecules. This is the fundamental process by which chlorophyll "captures" the energy of sunlight.

There are several kinds of chlorophyll, the most important being chlorophyll "a". This is the molecule which makes photosynthesis possible, by passing its energized electrons on to molecules which will manufacture sugars.

Regarding, the effect of the treatments on the total chlorophyll content of the sugar beet leaves was tabulated in Table (4). Some of the treatments increased significantly the chlorophyll content, whereas, the highest content of cholorophyll is related to azadirachtin (40.13) but, the lowest content of cholorphyll content achieved by the mixture of azadirachtin+ spinosad (23.26).

These results agree with others where, **Chris *et al.* (2011)** found that growth and photosynthetic pigments, i.e. chlorophyll and carotenoids were adversely affected by monocrotophos treatment and the inhibition was found to be dose dependent. Also, **Kumar *et al.* (2012)** found that all the pigments, metabolites and enzymatic activities of *Anaabenafertilissima*, *Aulosirafertilissima* and *Westillopsisprolifica*were dropped by between 59 to 96% upon various doses of pesticide treatments.

Table (4)Effect of certain pesticides on content of the total chlorophyll content in sugar beet leaves after 24 hours from application.

Treatments recommended doses	Cholorophyll
azadirachtin	40.13[a] ±0.272166
spinosad	26.6 [e] ±0.471405
methoxyfenozide	32.1[c] ±0.471405
fipronil	30.8[cd] ±0.471405
azadirachtin + spinosad	23.26[f] ±0.471405
azadirachtin + methoxyfenozide	31.6[c] ±0.471405
azadirachtin + fipronil	37 [b] ±0.471405
Untreated	29.4[d] ±0.471405
LSD .05	1.657

The same letters indicated in each column mean that the means are not significant at L.S.D $_{0.05}$

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الملخص العربي

الثاثيرالمتبقى والكيموحيوى لبعض المبيدات الجديدة على يرقات دودة ورق القطن وتأثيرها على محتوى الكلوروفيل في أوراق بنجرالسكر

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أجريت هذه الدراسة بمحطة بحوث الصبحية بمحافظة الاسكندرية خلال موسم ٢٠١٣ على دودة ورق القطن وذلك لتقييم الأثر المتبقي لبعض المبيدات الجديدة وهى رانر (ميثوكسي فينوزيد) و تريسر(سبينوساد) و بترا نيل (فيبرونيل) واخيرا سيف اويل (ازاديراختين) على العمر الرابع لدودة ورق القطن وذلك على فترات مختلفة بعد يوم و حتى سبعة ايام من الرش. كذلك تم دراسة التغيرات البيوكيميائية لتركيز بعض الأيونات غير العضوية في دم اليرقات نتيجة التغذية على أوراق معاملة بالمبيدات. علاوة على دراسة التأثيرات الجانبية على محتوى أوراق نبات بنجر السكر من الكلوروفيل.

قد نتج أعلى تأثير سام متبقي من معاملة رانر محققا ١٠٠% موت بعد ٤ أيام من المعاملة و تلاه بعد ذلك تريسر ثم كل من بترا نيل و سيف أويل. أما بعد ٧ أيام لم تكن هناك اختلافات معنوية في كفاءة رانر أو تريسر محققان ١٠٠ و ٩٥,٠٠ % موت أو بعد خلطهما مع سيف أويل معطيان ١٠٠ و ٩٦,٦٦ % موت.

أوضحت النتائج أن تركيز كل من المنجنيز و النحاس في دم يرقات دودة ورق القطن لم تتأثر معنويا بعد المعاملة بجميع المبيدات. بينما انخفضت معنويا تركيز باقي العناصر بواسطة المبيدين رانر و تريسر. كما أدت المعاملة بمبيد أزاديراختين أو بترا نيل الى انخفاض الكالسيوم و البوتاسيوم و الى زيادة تركيز الصوديوم في دم اليرقات.

و يمكن القول أن أكثر المبيدات كفاءة هما رانر و تريسر على العمر الرابع من يرقات دودة ورق القطن هي التي أدت أيضا الى أكبر خفض في تركيزات الكاتيونات في الدم خاصة الكالسيوم و الصوديوم و البوتاسيوم. لذلك ينصح بتوجيه الإهتمام الى دراسة تلك المكونات غير العضوية في دم الحشرات كمؤشرات حيوية لقياس كفاءة و سمية المبيدات الحشرية.

كذلك أظهرت النتائج أن مبيد أزاديراختين أدى الى زيادة محتوى الأوراق من الكلوروفيل بينما انخفض المحتوى مع المعاملة بمبيد تريسر.

كما توضح ايضا هذه الدراسة امكانية استخدام جرعات اقل من المبيدات الكيماوية لمكافحة دودة ورق عند الخلط مع زيت بذور النيم (سيف اويل) مما يمكن ان يقلل من خطر المبيدات على البيئة.