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Efficacy of some natural oils on the residual toxicity of Emamectin benzoate, Spinosad and Spinetoram against Egyptian cotton leafworm

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ABSTRACT

During the 2006 and 2007 growing seasons, two semi-field trials were carried out to determine the efficacy of two plant oils (neem and jojoba) and two light mineral oils (Star and Kemesol) on the persistence and residual toxicity of emamectin benzoate, spinosad and spinetoram as determined by cotton leafworm, *Spodoptera littoralis,* 2nd instar larvae bioassay. The aim of this study was to extend the residual life (increasing persistence) and to increase the residual toxicity of these insecticides. The tested insecticides were applied at the recommended rates, while oil concentrations were selected for field testing based on their performance in a laboratory study. Results showed that, jojoba oil (at 200 ppm) increased the residual toxicity of spinosad, spinetoram and emamectin benzoate against the 2nd instar larvae of *S. littoralis* during the two seasons. Also, neem oil (at 200 ppm) extended the residual toxicity of spinosad, spinetoram and emamectin benzoate, but to a lesser extent than jojoba oil. Although, Kemesol and Star mineral oils (at 1500 ppm) increased the toxicity of spinosad, spinetoram and emamectin benzoate in the laboratory, these oils had no effects on the residual toxicity of the tested insecticides in the field.

KeyWords: Cotton leafworm, spinosad, spinetoram, emamectin benzoate, plant oils, mineral oils.

INTRODUCTION

The cotton leafworm, *Spodoptera littoralis* Boisd., is one of the most important pests on cotton in Egypt. The insect is present during the whole cycle of the crop, requiring several chemical applications to control. The frequent use of insecticides against agricultural pests usually leads to the development of resistance in the target pests (Abo-El-Ghar *et al.*, 1986). To combat resistant pest species and sustain agricultural productivity, the

agrochemical industry has recently introduced new chemicals with novel modes of action unrelated to the previously used chemical classes. Emamectin benzoate, spinosad and spinetoram are from the recently new developed insecticides for control of lepidopterous pests.

Emamectin benzoate is a semi-synthetic derivative of abamectin and is currently being developed for control of lepidopterous pests on a variety of crops worldwide (Dybas *et al.*, 1989 and Jansson *et al.*, 1997). Impressive, broad spectrum control of lepidopterous pests on a variety of crops in the field has been demonstrated at low used rates (8.4-16.8 g ai/ha) (Jansson and Lecrone, 1992; Leibee *et al.*, 1995; Jansson *et al.*, 1996 and 1997). Emamectin benzoate is very compatible with integrated pest management (IPM). The mode of action of emamectin benzoate is similar to abamectin (a γ- aminobuteric acid (GABA) and glutamate-gated chloride channel agonist) according to Dunbar *et al.* (1998).

Spinosad is a naturally derived biorational insecticide with an environmentally favorable toxicity profile (Bond *et al.*, 2004). It is an insecticide based on an aerobic fermentation product of the bacterium *Saccharopolyspora spinosa* on nutrient media, and was discovered during the 1980s (Mertz and Yao, 1990). Spinosad belongs to a new class of polyketide-macrolide insecticides. In many countries, spinosad is used in control of lepidopteran pests in cotton, tobacco and other crops (Wyss *et al.*, 2003). The semi-synthetic compound, spinetoram is the second generation of spinosyns. Spinetoram is the active ingredient of the insecticide Radiant®.

Although the fore-mentioned compounds have a good insecticidal activity against the lepidopterous pests especially to the cotton leaf worm (Jansson *et al.*, 1997; Scarpellini, 2001; Ahmad *et al.*, 2003 and Aydin and Gurkan, 2006) the photo-degradation of these compounds reduces their half life and accordingly the residual activity against the target insects (MacConnell *et al.* 1989; Jansson *et al.* 1996 &1997; Tomkins *et al.*, 1999; Schmandke, 2001; Cleveland *et al.*, 2002 and Saunders and Bret, 1997). It is therefore relatively more expensive due to repeat spraying is necessary since the cotton leafworm is present throughout the cotton season. The trend of using photo-protective substances or spray adjuvants to increase the residual activity of the insecticides has been investigated by many authors. Photo-protection of the mosquitocidal activity of *Bacillus thuringiensis israelensis*, using melanin produced by *Streptomycete*, has been studied by Liu *et al.* (1993). Also, a range of spray adjuvants such as molasses, sucrose,

skimmed milk powder, and oxybenzone has been tested with *Cydia pomonella* L., granulovirus (CpGV) for the goal of improving virus uptake by larvae and/or increasing persistence of the virus on the surface of foliage or fruit (Ballard *et al.*, 2000; Charmillot *et al.*, 1998; Keller, 1973 and Krieg *et al.*, 1980).

Therefore, the aim of the present study was to improve the toxicity, to extend the residual life (increasing persistence) and to increase the residual toxicity of emamectin benzoate, spinosad and spinetoram on cotton plants, in field tests, through mixing them with certain plant oils (as sunlight screeners) or with mineral oils (as adjuvants).

MATERIALS AND METHODS

Experimental insect: Larvae of cotton leafworm, *S. littoralis,* were obtained from the Plant Protection Research Institute, Cairo. The colony was reared on castor oil leaves under laboratory conditions (27 ±2 °C, 65% RH) for several years avoiding exposure to any type of pesticides according to the method of Eldefrawi *et al.* (1964). The second instar larvae (2.3 ± 0.1 mg / larva) were used in the bioassay experiments.

Tested insecticides and oils: Emamectin benzoate (Proclaim® 5% SG; field rate is 60 gm/fed.) was supplied by Syngenta. Spinosad (Tracer® 24% SC; field rate is 50 ml/fed.) and spinetoram (Radiant® 12% SC; field rate is 50 ml/fed.) were obtained from Dow Agrosciences Co. The two mineral oils Kemesol 95% EC and Star oil 98% EC were supplied by Alexandria Chemical Co. (Kemex) and GINTRA-Egypt, respectively. The two plant oils, neem (85.5% purity) and jojoba (92.5% purity) were obtained by Egyptian Agriculture Development Co. and Egyptian Natural oil Co., respectively.

Laboratory studies: Laboratory studies were carried out to choose the appropriate oil concentrations to use in the field experiments. Toxicity of spinosad, spinetoram and emamectin benzoate against the 2nd instar larvae of *S. littoralis* was studied. Also, the effect of neem, jojoba, Kemesol and Star oils on the toxicity of these insecticides against the 2nd instar larvae of *S. littoralis* was investigated. Castor oil leaves dipping technique was used according to Eldefrawi *et al.*, (1964). Castor oil leaf discs (5 cm diameter) were cut with a metal punch and dipped in a test solution prepared in distilled water, held vertically to allow excess solution to drop off and then,

flattened to dry the test solution. Ten 2nd instar larvae (2.3 ± 0.1 mg / larva) were released on two discs in an individual plastic cup. Six serial dilutions of each insecticide were used with four replications for each concentration. Effects of neem, jojoba, Kemesol and Star oils on the toxicity of these insecticides were carried out by mixing a serial of each insecticide concentrations with a number of each oil concentrations (200, 400 and 800 ppm for plant oils and 1500, 3000 and 4500 ppm for mineral oils). In the case of plant oils, Triton X-100 (0.01 %) had been added to the solution as an emulsifier. Control larvae were fed on castor oil leaf discs dipped in a solution containing distilled water and Triton X-100 (0.01 %). Larvae were left to feed on the treated leaf discs for 72 hrs at 27 °C then, mortality being checked. Mortality percentages were corrected according to Abbott equation (Abbott, 1925) and subjected to probit analysis (Finney, 1971). LC_{50} values with their 95% confidence limits with and without tested oils were calculated to select the appropriate oil concentration to use in the field studies.

Field Trials: Two field experiments were conducted during 2006 and 2007 summer seasons at Alexandria University Experiment Station, Abees, Alexandria Governorate. The cultivated cotton variety was Giza 70. All cultural practices were carried out according to "good agricultural practice". All treatments were assigned to plots in a randomized complete block design. Each insecticide at the field recommended rate alone and its combination with the selected concentration of the plant oils (200 ppm) or the mineral oils (1500 ppm) were studied. Because plant oils at 400 and 800 ppm decreased the toxicity of the tested insecticide, 200 ppm of the plant oils was chosen (Data not presented in Tables). Also, mineral oils at 3000 and 4500 ppm had the same effect on the toxicity of the tested insecticides as 1500 ppm, therefore mineral oils at 1500 ppm was chosen (Data not presented in Tables). Control was sprayed by water only. Each treatment was replicated four times. Sprays were carried out once using Knapsack sprayer equipment (CP3) at the rate of 200 liter per feddan during the month of August, 2006 and 2007. Cotton leaves from treated and untreated (control) plots were collected from three levels of plants in perforated bags at 0, 3, 5, 7, 9 days after application and transferred to the laboratory. Two leaves of each sample were placed in a plastic cup containing 10 larvae of cotton leafworm. Four replicates were used for each treatment in addition to the untreated control. The experiment was maintained at 27 °C and 65 % RH. Mortalities were recorded after 72 hrs of exposure, corrected according to Abbott equation (Abbott, 1925) and subjected to analysis of variance

(ANOVA) (CoStat Statistical Software, 1990). The standard deviation (SD) of four replications was calculated.

RESULTS

Laboratory studies: Laboratory studies were carried out at first to select the suitable oil concentrations. Tables (1, 2 and 3) show the LC_{50} values of spinosad, spinetoram and emamectin benzoate against the 2nd instar larvae of *S. littoralis* with and without one concentration from the tested oils. Both neem and jojoba oils at concentration of 200 ppm had no effect on the toxicity of spinosad against the 2nd instar larvae of *S. littoralis*. While the LC_{50} of spinosad alone was 41.3 ppm, the LC_{50} values of spinosad were 41.5 and 41.1 ppm when spinosad were mixed with neem and jojoba oils at 200 ppm, respectively. On the other hand, the mineral oils increased the toxicity of spinosad. The LC_{50} value of spinosad alone was decreased from 41.3 ppm to 30.2 ppm when spinosad was mixed with Kemesol at 1500 ppm and became 27.4 ppm when mixed with Star oil at the same concentration (Table1).

Table (1). Effect of certain plant and mineral oils on the LC_{50} values of Spinosad against the 2nd instar larvae of *S. littoralis*:

Treatments		Oil conc. (ppm)	LC_{50} (ppm)	95% confidence limits	
				Lower limit	Upper limit
Spinosad	alone	0.0	41.3	38.7	44.1
	+Neem	200	41.5	39.2	43.4
	+Jojoba	200	41.1	38.4	44.7
	+Kemesol	1500	30.2	27.5	33.1
	+Star	1500	27.4	24.8	30.2

The same trends were observed when spinetoram was mixed with the plant or mineral oils. While the LC_{50} of spinetoram alone was 8.8 ppm, the LC_{50} values of spinetoram were 8.5 and 8.7 ppm when spinetoram was mixed with either neem or jojoba oil at 200 ppm, respectively. Both Kemesol and Star oils increased the toxicity of spinetoram, against the 2nd instar larvae of *S. littoralis*, by approximately 2-fold. The LC_{50} values of

spinetoram were 5.1 and 4.6 ppm when spinetoram was mixed with Kemesol or Star oil at 1500 ppm, respectively (Table 2).

Table (2). Effect of certain plant and mineral oils on the LC_{50} values of spinetoram against the 2nd instar larvae of *S. littoralis*:

Treatments		Oil conc. (ppm)	LC_{50} (ppm)	95% confidence limits	
				Lower limit	Upper limit
Spinetoram	alone	0.0	8.8	7.3	9.5
	+Neem	200	8.5	7.1	9.7
	+Jojoba	200	8.7	7.0	10.3
	+Kemesol	1500	5.1	4.0	6.2
	+Star	1500	4.6	3.8	5.2

The tested plant and mineral oils had a slight effect on the toxicity of emamectin benzoate against the 2nd instar larvae of *S. littoralis* (Table 3). While the LC_{50} of emamectin benzoate alone was 1×10^{-3} ppm, approximately, the same value was obtained when emamectin benzoate was mixed with the neem or jojoba oil at 200 ppm. Also, the LC_{50} values of spinetoram were 0.8×10^{-3} and 0.85×10^{-3}ppm when emamectin benzoate was mixed with Kemesol and Star oils at 1500 ppm.

Table (3). Effect of certain plant and mineral oils on the LC_{50} values of emamectin benzoate against the 2nd instar larvae of *S. littoralis*:

Treatments		Oil conc. (ppm)	$LC_{50} \times 10^{-3}$ (ppm)	95% confidence limits	
				Lower limit	Upper limit
Emamectin benzoate	alone	0.0	1.0	0.90	1.00
	+Neem	200	1.0	0.94	1.06
	+Jojoba	200	0.9	0.87	0.94
	+Kemesol	1500	0.8	0.78	0.81
	+Star	1500	0.85	0.84	0.86

Semi-field studies: Efficacy of certain plant and mineral oils on the field persistence and residual toxicity of spinosad, spinetoram and emamectin benzoate on cotton foliage as determined by *S. littoralis* bioassay is shown

in Figures (1, 2 and 3). Results from Fig. (1. A & B) showed that both neem and jojoba oils increased the residual toxicity of spinosad against the 2nd instar larvae of *S. littoralis* at the seasons, 2006 and 2007. Mortality percentages of the *S. littoralis* 2nd instar larvae which exposed to cotton leaves treated (in the field) by spinosad only and collected after 0, 3, 5, 7 and 9 days post-treatment were 100, 76.7, 43.3, 16.7 and 6.7 %, respectively, at season 2006, and 100, 80, 46.7, 10 and 3.3 %, respectively, at season 2007. When spinosad/neem oil mixture was used these percentages of mortality were 100, 83.3, 56.7, 33.3 and 13.3 %, respectively, at season 2006, and 100, 83.3, 53.3, 30 and 13.3 %, respectively, at season 2007.

Larval mortality percentages were 100, 93.3, 80, 60 & 40 %, and 100, 93.3, 83.3, 56.7 & 43.3 %, at 2006 & 2007, after 0, 3, 5, 7 and 9 days of insecticides application, respectively. From these data it is clear that, spinosad / jojoba oil mixture revealed a residual toxicity, against the 2nd instar larvae of *S. littoralis*, higher than spinosad / neem oil mixture. On day 9, toxicity of spinosad / jojoba oil and spinosad / neem oil mixtures was 6 & 2-fold the toxicity of spinosad alone, in 2006 season, and 13.1 & 4-fold in season 2007, respectively.

Similar results were found when spinetoram / neem oil and spinetoram / jojoba oil mixtures were tested (Fig. 2. A & B). In season 2006, mortality percentages results from spraying of spinetoram alone were 100, 70, 40, 20 and 3.3 %, on days 0, 3, 5, 7 and 9, respectively. These percentages were 100, 80, 53.3, 36.7 and 10 %, respectively, when spinetoram / neem oil mixture was used, and 100, 93.3, 80, 60 and 43.3 %, respectively, when spinetoram / jojoba oil mixture was used. Data from the 2007 season concurred with those from the 2006 season. Mortality percentages were 100, 60, 36.7, 10 and 3.3 %, on days 0, 3, 5, 7 and 9, respectively, when spinetoram alone was used.

These percentages were 100, 70, 46.7, 30 and 13.3 %, respectively, when spinetoram / neem oil mixture was used, and 100, 86.7, 83.3, 56.7 and 33.3 %, respectively, when spinetoram / jojoba oil mixture was used. From these data, spinetoram / jojoba oil mixture revealed toxicity on day 9, 13.1 and 10.1- fold the toxicity of spinetoram alone, in seasons 2006 and 2007, respectively. On day 9, toxicity of spinetoram / neem oil mixture was 3 and 4-fold the toxicity of spinetoram alone, in 2006 and 2007 seasons, respectively.

Figure (3). A & B. represents the efficacy of both neem and jojoba oils on the residual toxicity of emamectin benzoate as determined by *S. littoralis* 2nd instar larvae bioassay in 2006 and 2007 seasons. It is clear that jojoba oil increased the residual toxicity of emamectin benzoate. Also, neem oil increased the residual toxicity of emamectin benzoate but lesser than the jojoba oil. In season 2006, mortality percentages results from spraying of emamectin benzoate alone were 100, 73.3, 50, 13.3 and 3.3 %, on days 0, 3, 5, 7 and 9, respectively.

These percentages were 100, 80, 53.3, 30 and 6.7 %, respectively, when emamectin benzoate / neem oil mixture was used, and 100, 90, 83.3, 56.7 and 36.7 %, respectively, when emamectin benzoate / jojoba oil mixture was used. Data from the 2007 season was compatible with those from the 2006 season.

Mortality percentages were 100, 86.7, 56.7, 16.7 and 6.7 %, on days 0, 3, 5, 7 and 9, respectively, when emamectin benzoate alone was used. These percentages were 100, 90, 66.7, 36.7 and 13.3 %, respectively, when emamectin benzoate / neem oil mixture was used, and 100, 96.7, 83.3, 66.7 and 40 %, respectively, when emamectin benzoate / jojoba oil mixture was used.

Generally, the toxicity of emamectin benzoate / jojoba oil mixture, on day 9, was 11.1 and 6- fold the toxicity of emamectin benzoate alone, in seasons 2006 and 2007, respectively. Also, on day 9, toxicity of emamectin benzoate / neem oil mixture was 2 and 2-fold the toxicity of emamectin benzoate alone, in 2006 and 2007 seasons, respectively.

From all the fore-mentioned results, we can conclude that jojoba oil significantly extended and increased the residual toxicity of the tested insecticides in the field. Neem oil slightly increased the residual toxicity of these insecticides.

Although, Kemesol and Star mineral oils increased the toxicity of spinosad, spinetoram and emamectin benzoate in the laboratory, these oils had no effects on the residual toxicity of the tested insecticides in the field as determined by the 2nd instar larvae of *S. littoralis* bioassay (Figs. 1, 2 and 3).

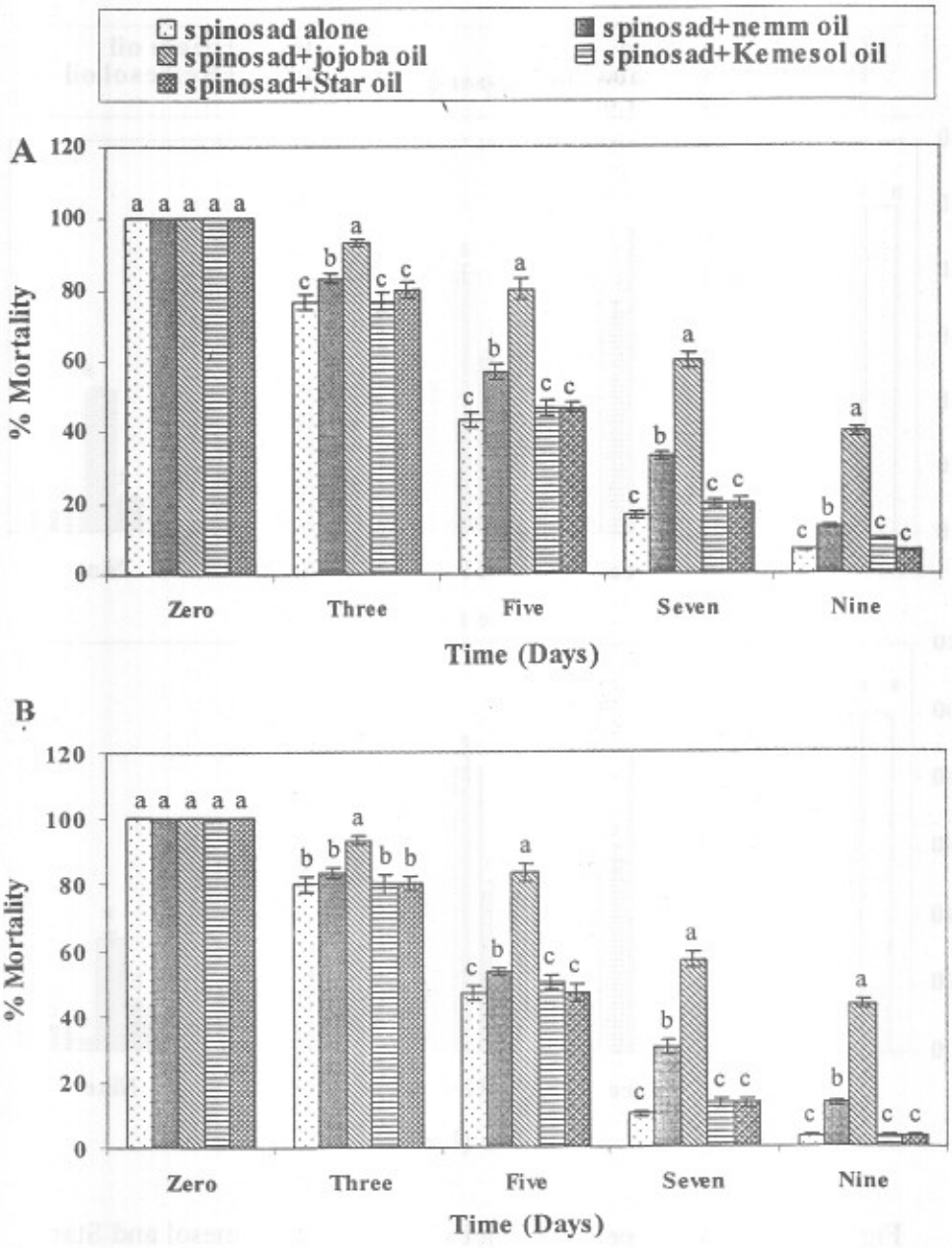

Fig.(1): Efficacy of neem and jojoba plant oils & Kemesol and Star mineral oils on the residual toxicity of spinosad against *S. littoralis* 2nd instar larvae, (A) season 2006 & (B) season 2007. Error bars represent standard deviation of four replications. Columns within a group with a letter in common are not significantly different

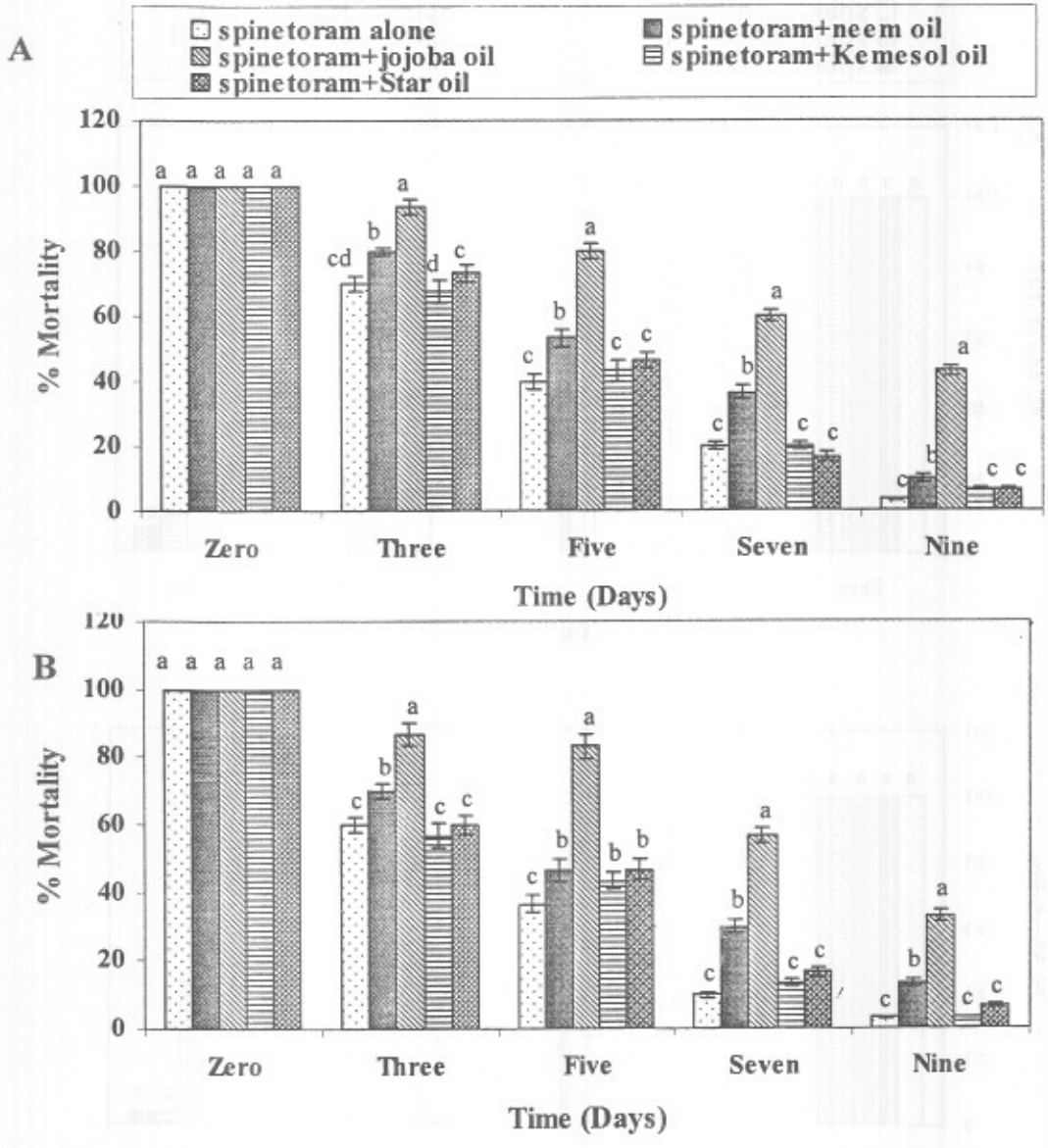

Fig.(2): Efficacy of neem and jojoba plant oils & Kemesol and Star mineral oils on the residual toxicity of spinetoram against *S. littoralis* 2nd instar larvae, (A) season 2006 & (B) season 2007. Error bars represent standard deviation of four replications. Columns within a group with a letter in common are not significantly different according to Student-Newman Keuls (SNK) test (LSD at $P < 0.05$).

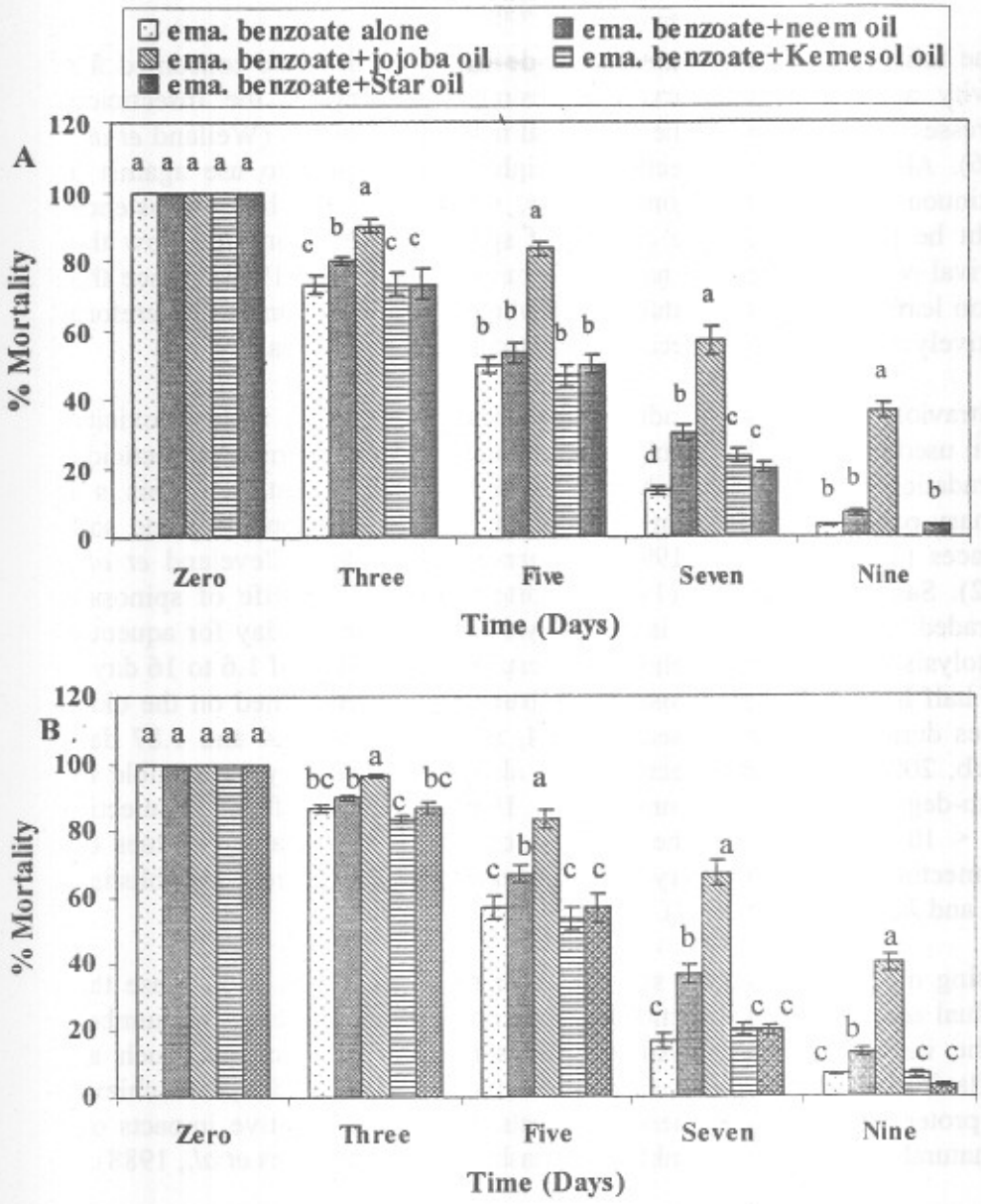

Fig.(3): Efficacy of neem and jojoba plant oils & Kemesol and Star mineral oils on the residual toxicity of emamectin benzoate (ema. benzoate) against *S. littoralis* 2nd instar larvae, (A) season 2006 & (B) season 2007. Error bars represent standard deviation of four replications. Columns within a group with a letter in common are not significantly different according to Student-Newman Keuls (SNK) test (LSD at $P < 0.05$).

DISCUSSION

The foliar persistence of an insecticide which needs to be consumed for activity against feeding larvae is desirable as long as the insecticide expresses little activity on the beneficial insect populations (Weiland *et al.*, 1996). Also, persistent insecticides might be preferable to use against a continuous, heavy infestation of pests, while those of short persistence might be preferable for the control of sporadic infestations to allow the survival reestablishment of natural enemies (Raha *et al.*, 1993). Since the cotton leafworm is present during the whole cycle of cotton, it is therefore relatively more expensive because repeated spraying is necessary.

Ultraviolet and ionizing radiation can cause insecticides to lose toxicity when used in the field. Photolysis is the main pathway of much insecticide degradation on plant foliage. Many studies have shown that photolysis is a primary pathway of spinosyn degradation in water, and on plant and soil surfaces (Tomkins *et al.*, 1999; Schmandke, 2001 and Cleveland *et al.*, 2002). Saunders and Bret (1997) reported that, the half-life of spinosad degraded by soil photolysis is 9-10 days. It is less than 1 day for aqueous photolysis and leaf surface photolysis results in a half-life of 1.6 to 16 days. The half life values of spinosad and abamectin as determined on the okra leaves during the summer season 2004, in Eygpt, were 1.4 and 1.87 day (Azab, 2006). Also, avermectins (e.g., abamectin) are very susceptible to photo-degradation (Mac-Connell *et al.* 1989). The half-life of abamectin was < 10 h in light and the half-life for foliar dislodgeable residues of emamectin benzoate on celery was approximately 15 h (Merck, unpublished data and Jansson *et al.*, 1997).

Using of photo-protective substances or spray adjuvants to increase the residual activity of the insecticides may contribute in reducing the number of the insecticide sprays. Addition of some chemical screens, such as acriflavine and methyl green, as components of the formulation, can achieve UV-protection. However, these chemicals have some negative impacts on the natural environment (Dunkle and Shasha, 1989; Margulies *et al.*, 1988).

In the present study, two plant oils and two light mineral oils were used to extend and to improve the residual toxicity of spinosad, spinetoram and emamectin benzoate in the field. The insecticides were applied at the recommended rates. Because neem and jojoba oils have an antifeedant

effects laboratory studies were carried out to choose the appropriate oil concentrations to use it in the field experiments. Therefore, oil concentrations were selected for field testing based on their performance in the laboratory studies. Results revealed that, jojoba oil extended the residual toxicity of spinosad, spinetoram and emamectin benzoate in the field as determined by *S. littoralis* 2nd instar larvae bioassay. Since jojoba oil at 200 ppm had no effects on the toxicity of the tested insecticides in the laboratory, the extending of residual toxicity of these insecticides in the field may refer to the photo-protection. Jojoba oil exhibits extraordinary high thermal and oxidative stabilities (Tobares *et al.*, 2004). Approximately, 50 wt.% of the weight of the seed is a mixture of long-chain liquid esters. As much as 97 wt.% of jojoba seed oil consists of a mixture of esters of long-chain fatty alcohols and long-chain fatty acids. More than 60 wt. % of this mixture of esters contains *cis*-11-eicosenoic (jojobenoic) acid (C20). Therefore, jojoba seed oil as one of the top cosmetic lipid materials in use today is one of the finest cosmetic ingredients in the world. Because, jojoba seed oil resists hydrolysis and oxidation for more effective, non-occlusive, moisture control and photo-protection on the external surfaces of skin, hair, eyes. Antifoaming agents, detergents, emulsifiers, fibers, protective coatings, resins, and surfactants are the other way of using area. Because of its low toxicity and its rapid degradation in the environment, jojoba seed oil does not pose a risk to nontarget organisms or the environment (Wisniak, 1987; Abu-Arabi *et al.*, 2000; Salunkhe *et al.*, 1992; Borlaug *et al.*, 1985). Jansson *et al.* (1996) reported that the reduced photodegradation of emamectin benzoate in the glasshouse (glasshouses are known to filter out a large percentage of UV light) optimized the amount that was able to penetrate leaf tissue via translaminar movement and subsequently prolong the residual efficacy.

Efficacy of neem products in insect control was reviewed by many scientists (Saxena, 1989; Schemutterer, 1990). In this study neem oil extended the residual toxicity of spinosad, spinetoram and emamectin benzoate, but to a lesser extent than jojoba oil. These results were compatible with the results obtained by Sahayaraj and Amalraj (2006). They reported that, the monocrotophos and neem oil combination was found to be very effective in reducing the defoliator (*Aproaerma modicella*, *Helicoverpa armigera* and *Spodoptera litura*) infestation on the groundnut. On the other hand, the use of several spray adjuvants, such as Trilogy® (neem oil at 1% v/v) did not provide solar protection of a commercial *Cydia pomonella* L., granulovirus preparation in laboratory tests (Arthurs *et al.*, 2006).

Mineral oils are known from a long time such as an effective mean to control aphids and to reduce non-persistent viruses spread (Russell, 1970; Brachet *et al.*, 2001). Also, mineral oils were used to control powdery mildew strawberry (Pertot *et al.*, 2008). In the present work, although, Kemesol and Star mineral oils increased the toxicity of spinosad, spinetoram and emamectin benzoate in the laboratory, these oils had no effects on the residual toxicity of spinosad, spinetoram and emamectin benzoate in the field as determined by the 2nd instar larvae of *S. littoralis* bioassay. This may refer to the low concentration (1500 ppm = 0.15 %) of the mineral oils which used in this study. Another field expirement may be needed with higher mineral oil concentrations. These results were comparable in part with the results reported by Picanco *et al.* (1998). They stated that, while the insecticide abamectin mixed with mineral oil (at 0.5 %) provided a best control of *Neoleucinodes eleguntulis* in tomatoes, there was no significant effect of this mixture in reducing tomatoes fruit damage by *Helicoverpa. zea* and *Tuta absoluta.*

Reduction in the insecticide applications can be achieved by many techniques (such as: crop rotation, use the suitable planting date, scouting fields for insects, insecticide spray rotations, spot spraying, etc...). In this study, the reduction of the insecticide usage and obtaining a good pest control can be achieved through the extending and increasing the residual toxicity of the insecticides. Through this study, the reduction of the insecticide applications can be achieved with the insecticides / jojoba oil mixtures. This might raise the production outputs and help in implementing IPM programs.

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تأثير بعض الزيوت الطبيعية على سمية المتبقى لمبيدات الإمامكتين بنزوات والإسبينوساد والإسبينيتورام على دودة ورق القطن

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تم إجراء تجربتين عامى 2006 و 2007 فى حقل قطن وذلك لدراسة تأثيرزيتين نباتيين (النيم والجوجوبا) وزيتين معدنيين (كيميسول و الستارأويل) على بقاء وكذلك سمية المتبقى لمبيدات الإمامكتين بنزوات والإسبينوساد والإسبينيتورام على يرقات العمر الثانى لدودة ورق القطن. الهدف من هذه الدراسة هو العمل على تمديد التأثير المتبقى للمبيدات محل الدراسة وكذلك زيادة سمية المتبقى. تم تطبيق المبيدات بالجرعة الموصى بها حقليا بينما تم إختيار تركيزات الزيوت بناءا على دراسة معملية.

أظهرت النتائج أن زيت الجوجوبا عند تركيز 200 جزء فى المليون عمل على تمديد سمية المبيدات المختبرة على العمر اليرقى الثانى لدودة ورق القطن ، خلال العامين التجريبيين. أما عند إستخدام زيت النيم بتركيز 200 جزء فى المليون فإنه أدى إلى تمديد سمية المبيدات المختبرة ولكن بدرجة أقل من زيت الجوجوبا. على الرغم من أن الزيت المعدنى كيميسول والزيت العدنى ستارأويل عند تركيز 1500 جزء فى المليون عملا على زيادة سمية مبيدات الإمامكتين بنزوات والإسبينوساد والإسبينيتورام فى المعمل فإنه لم يكن لهما تأثير على سمية هذه المبيدات فى الحقل على يرقات العمر الثانى لدودة ورق القطن.