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Original Article

# Toxicological study of some conventional and nonconventional insecticides and their mixtures against cotton leaf worm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noectudae)

**E.E.E. Korrat *, A.E. Abdelmonem, A.A.R. Helalia, H.M.S. Khalifa**

*Plant Protection Department, Faculty of Agriculture, Al. Azhar University, Cairo, Egypt*

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Profenofos

**Abstract** The effects of conventional (profenofos) and nonconventional (emamectin benzoate, spinosad and chlorfluazuron) insecticides at their $LC_{10}$, $LC_{25}$ and $LC_{50}$ and their binary mixtures were evaluated against 2nd instar larvae of cotton leaf worm, *Spodoptera littoralis* (Boisd.) under laboratory conditions. After 3 days of the treatment, emamectin benzoate was the most effective insecticide ($LC_{50}$ = 0.017 ppm) followed by chlorfluazuron ($LC_{50}$ = 0.42 ppm) and profenofos ($LC_{50}$ = 10.9 ppm) and finally spinosad which showed the lowest toxic effect ($LC_{50}$ = 19.9 ppm). After 12 days of the treatment, and at the $LC_{25}$ level, spinosad showed the longest residual effect followed by chlorfluazuron, and then profenofos and emamectin benzoate. At the same concentration level, spinosad and chlorfluazuron had the higher effects on pupation, moth emergence, hatchability and sterility. Chlorfluazuron, especially at $LC_{50}$, caused the highest effect on the percentages of deformed pupae and moths (14.86% and 32.76%, respectively). In general, all the tested mixtures increased mortality percentages of larvae. The highest potency was observed with the mixture of profenofos (at $LC_{10}$) and chlorfluazuron (at $LC_{50}$) which produced potentiation. However, the mixtures of both emamectin benzoate and spinosad with profenofos produced additive effects. Mixtures of chlorfluazuron and emamectin benzoate (at $LC_{50}$) with profenofos at $LC_{10}$ gave the highest effect on biological parameters [there is no pupa comparing with the control (86.66%)]. Also, mixtures of spinosad (at $LC_{50}$) with profenofos at $LC_{10}$ and $LC_{25}$ gave the highest effect on egg production 393.9 egg/female and hatchability (19.17%), comparing with the control (1151.6 egg/female

* Corresponding author. Tel.: +20 01008993860.
E-mail address: Ehab_2010239@yahoo.com (E.E.E. Korrat).

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and 96.36%). The obtained results indicated that mixtures of conventional–nonconventional insecticides had the combined advantages of quick speed of killing and a high level of safety. Moreover, these mixtures probably affected by the existing resistance mechanism to conventional insecticides.



## Introduction

Cotton is one of the most important crops and a major source of the national economy of Egypt. The Egyptian cotton leaf worm, *Spodoptera littoralis* (Boisd.) is one of the most harmful insect cotton pests in Egypt. It causes considerable damage to cotton plants as well as more than 29 hosts from other crops and vegetables. The environmental hazards of conventional insecticides necessitate introduce of other new insecticides that are effective, safer for human and negligible effects on ecosystem.

The mechanisms of action of the examined compounds are studied previously. The organophosphates effect on acetylcholinesterase. Spinosad causes persistent activation of nicotinic acetylcholine (ACT) receptors. Because ACT and spinosad act on receptors simultaneously, they likely operate at different target sites; this apparently is unique nicotinic agonists, which normally compete directly with ACT for binding sites (Salgado et al., 1997). Emamectin benzoate inhibits muscle contraction, causing a continuous flow of chlorine ions in the Gama Amino Butyric Acid (GABA) and H-Glutamate receptor sites (Fanigliulo and Sacchetti, 2008). The benzoylphenyl ureas constitute a class of Insect Growth Regulators (IGRs) that interfere with insect growth and development by inhibiting chitin synthesis in insect (Post and Vincent, 1973).

Chemical–bioinsecticides combination provides several distinct advantages for Insect Pest Management programs (IPMs), including the potential effect for reducing the amounts of each agent used. Such reduction would mean potentially lower costs, lower environmental pollution, less damage to beneficial organisms and reduced selection pressure leading to the development of resistance to each agent (Harper, 1987 and Temerak, 2005).

The goal of the present investigation is to study the effect of three concentrations (at $LC_{10}$, $LC_{25}$ and $LC_{50}$) of conventional (profenofos) and nonconventional (emamectin benzoate, spinosad and chlorfluazuron) insecticides and their binary mixtures on mortality and some biological parameters of *S. littoralis* (Boisd.) under laboratory conditions.

## Materials and methods

### *Rearing technique*

The strain of *S. littoralis* (Boisd.) of this study originally was obtained from Plant Protection Institute, Agriculture Research Center, Dokki, Giza, Egypt. This strain was not previously exposed to any insecticides. The colony was reared under constant conditions at 25 ± 2 OC, 65 ± 5% R.H. and photoperiod 12:12 L:D for six successive generations as described by El-Defrawi et al. (1964). Egg masses were kept in glass jars (500 ml) covered with muslin cloth and provided daily with fresh castor bean leaves (*Ricinus communis*) as a source of food for the larvae. Third instar larvae (6-days old) were transferred to glass jars (1 l) provided with the same food. The prepupae were allowed to pupate in clean jars containing 2 cm high dry sawdust. The resulting pupae were transferred to glass jars containing filter papers and were kept in suitable cages (35 × 35 × 35 cm) for mating of the emerged moths. Emerged moths were fed on a piece of cotton dipped in 10% sugar solution. The cages were supplied with fresh leaves of *Nerium oleander* (L.) that served as an oviposition site.

### *Tested compounds*

1. *Profenofos (Selecron 72% EC) is an* organophosphate compound purchased from Syngenta chemical company.
2. *Emamectin benzoate (Proclaim 5% SG) is a bio-insecticide produced* by the soil microorganism, *Streptomyces avermitilis* purchased from Syngenta chemical company.
3. *Spinosad (Tracer 24% SC)* is an extract of the fermentation broth of soil actinomycete bacterium, *Saccharopolyspora spinosa*, purchased from Agrochem Co., Alexandria
4. *Chlorfluazuron (Topron 5% EC) is a* benzoylphenylurea compound purchased from Agrochem Co., Alexandria.

### *Determination of the LC values of the tested insecticides*

The $LC_{10}$, $LC_{25}$ and $LC_{50}$ values of conventional and nonconventional insecticides were determined using the leaf dipping technique. Dry and clean castor bean leaves were dipped for 15 s in six different concentrations of the tested insecticides, then left to air dry for 1 h under room temperature and then offered to 2nd instar larvae in clean jar, each jar contained 10 larvae. Four replicates were used for each concentration of each treatment. Leaves dipped in water served as control. The $LC_{10}$, $LC_{25}$ and $LC_{50}$ values that obtained by regression lines were statistically estimated and the goodness of fit of the regression lines to the observed data was calculated after 3 days according to Finney (1971).

The joint action between conventional insecticide (profenofos) at $LC_{10}$ and $LC_{25}$ with nonconventional insecticides (chlorfluazuron, emamectin benzoate and spinosad) at $LC_{10}$, $LC_{25}$ and $LC_{50}$ was determined according to the equation of the co-toxicity factors (C.Fs) given by Mansour et al. (1966) as follows:

$$\mathbf{C.F} = [\text{Observed mortality }\% - \text{Expected mortality }\%/\text{Expected mortality }\%] \times 100$$

The authors reported that a positive factor of 20 or more is considered potentiation, a factor of −20 or less means antagonism, and a value between −20 and +20 is an additive effect expected.