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M Mahesh
M.Sc. Agriculture, Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

V Sunitha
Scientist, AINP on Vertebrate Pest Management, PJTSAU, Rajendra nagar, Hyderabad, Telangana, India

J Satyanarayana
Dean of Agriculture, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

TVK Singh
Dean of Agriculture Retired, PJTSAU, Rajendra Nagar, Hyderabad, Telangana, India

R Jagadeeshwar
Director of Research, PJTSAU, Rajendra nagar, Hyderabad, Telangana, India

Corresponding Author:
M Mahesh
M.Sc. Agriculture, Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

Relative toxicity of new insecticide molecules against field population of *Spodoptera litura* (Fab.)

M Mahesh, V Sunitha, J Satyanarayana, TVK Singh and R Jagadeeshwar

Abstract

The present investigation was conducted on relative toxicity of four new insecticide molecules against third instar larvae of tobacco caterpillar *Spodoptera litura* (Fab.) by using leaf dip bioassay technique under laboratory conditions at Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad. The egg mass of *Spodoptera litura* was collected from Rangareddy district and reared under laboratory condition until pupation on castor leaves. Sexing was done at pupal stage. After adult emergence, single female was paired with male kept in a plastic jar, provided with white paper as substrate for egg laying. Collected these eggs and after hatching the larvae were reared on castor leaves under laboratory condition. The third instar larvae were used for bioassay. Among the various insecticides tested, chlorantraniliprole was found to be most toxic with least LC_{50} value (0.0055%) followed by chlorfenapyr, thiodicarb and chlorpyriphos. The order of toxicity based on LC_{50} values was chlorantraniliprole (0.0055%) > chlorfenapyr (0.0073%) > thiodicarb (0.019%) and chlorpyriphos (0.0232%) respectively, and chlorantraniliprole, chlorfenapyr and thiodicarb showed 4.21, 3.17 and 1.22 times toxic over chlorpyriphos at 72 hours after exposure.

Keywords: LC_{50}, *Spodoptera litura*, relative toxicity, new insecticide molecule

Introduction

Tobacco caterpillar, Spodoptera litura (Fab.) (Lepidoptera: Noctuidae) is a polyphagous pest which was reported on about 112 cultivated plants and is capable of causing 25.8 to 100 per cent losses in different crops based on crop stage and its infestation level in the field Dhir *et al*.(1992) [1]. A number of insecticides have been proved to be effective against this pest, but their indiscriminate and extensive use has resulted in development of resistance, that has led to sporadic outbreaks of the pest and thus leading to the failure of crops Ahmad *et al*. (2007) [2]. Keeping this in view, the present study was planned to determine toxicity of new molecules with diversified mode of action against this pest in the laboratory to provide organised guidance for the selection of pesticides for management of the pest.

Materials and Methods

The present investigation was carried out under laboratory conditions during 2016-17 at Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad, and Telangana. The egg masses of S. litura collected from cabbage fields in Rangareddy district was kept separately in glass jars. Tender castor leaves were provided as food for neonate larvae immediately after hatching to prevent mortality of larvae and feed was changed regularly for every eight hours until pre-pupation. The rearing space was increased regularly using more number of glass jars for avoiding crowding of the larva and to enable uniform growth and development of the larvae. After fifth instar, larvae entering pre-pupal stage were left for wandering in plastic tubs partially filled with sand and saw dust in 1:1 ratio. After three to four days of pupation, sexing of the pupae was carried out based on the markings present on ventral side of the abdomen. Pupae were surface sterilized with 2 per cent Sodium hypochlorite solution followed by washing with distilled water for 2-3 times and later wrapped in tissue paper for removing the moisture. Male and female pupae were kept separately in plastic jars (15cms x 13cms). After adult emergence, single female was paired with male kept in a plastic jar, provided with white paper as substrate for egg laying and cotton swab containing 10 ml of honey + 90 ml of distilled water as food. These jars were kept at 27±2 °C, 75±5 per cent RH and a photoperiod of 14:10 L: D and pairs was monitored daily for egg

Laying and after hatching, the neonates were transferred to glass jars with fresh castor leaves.

Test Insecticides

Commercial formulations of four newer insecticide molecules from different classes Ie., Chlorantraniliprole 18.5 SC (Coragen), Du-Pont India Ltd, Chlorfenapyr 10 SC (Intrepid), BASF India Ltd, Chlorpyrifos 20 EC (Lethal), M/s. Insecticides India Ltd, and Thiodicarb 75 WP (Larvin), M/s. Bayer Crop Science Ltd, representing diamide, pyrrole, organophosphates and carbamates, respectively, selected for testing their toxicity against S. litura.

Preparation of stock solution of insecticides

One per cent stock solution of the test insecticides were prepared by employing the following formula.

$$\text{Stock solution} = \frac{\text{Required concentration (1\%)}}{\text{\% formulation of test insecticide}} \text{ x } 100^*$$

Quantity of water taken for the preparation of solution

Hundred milliliters of one per cent stock solution was used for the preparation of serial dilutions as desired. Initially broad concentrations were tested for each test insecticide. Depending on the mortality observed and then narrow range concentrations were tested until larval mortality could be obtained to a range of 20.00 to 80.00 per cent.

Laboratory bioassay

Bioassay was conducted with third instar larvae of S. litura by using standard leaf dip method to evaluate toxicity of test insecticide molecules. Different concentrations of each test insecticides were used for the bioassay.

The tender fresh uniform sized castor leaves were made into leaf discs of 10 cm diameter and were dipped in different insecticidal solution for 20 seconds with gentle agitation. The treated leaf discs were then allowed to air dry on filter paper for 5 minutes, to avoid desiccation of leaves, moistened filter paper was placed beneath the leaf in each petri dish.

Ten third instar larvae of S. litura with an average weight of 30±0.011 mg of 7±1 day were released in to each petri dish and the leaf disc dipped in distilled water, served as control. Three replications were maintained for each insecticidal concentration and 10 larvae were released in each replication.

Observations

Mortality of the treated larva was recorded at 24, 48, and 72 hrs after treatment by counting the dead larvae or moribund when they did not resume activity after repeated prodding's. Mortality at 72 hours after treatment was considered as end point for the assessment of the toxicity of test insecticide Fisk and Wright (1992) [3]

Data on mortality was subjected to probit analysis Finney (1971) [4] and, LC50, LC90, heterogeneity, intercept (a), slope of the regression line (b), and regression equation were calculated.

The degrees of relative toxicity among the insecticides were determined by the LC50 of less toxic compound to LC50 of individual toxic compound.

$$\text{Relative toxicity} = \frac{LC_{50} \text{ of less toxic compound}}{LC_{50} \text{ of individual toxic compound}}$$

Results

Relative toxicity indicated that among the four insecticides evaluated against third instar larvae of S. litura using leaf dip method, with reference to LC50 chlorantraniliprole was highly toxic to S. litura with lowest LC50 value 0.0055 per cent followed by chlorfenapyr, thiodicarb and chlorpyriphos with LC50 values 0.0073, 0.0190 and 0.0232 per cent, respectively. It is evident from the data that chlorantraniliprole, chlorfenapyr and thiodicarb were 4.21, 3.17, 1.22 times toxic over chlorpyriphos (Table 1 & Fig.1). The order of relative toxicity based on LC50 values in the descending order was chlorantraniliprole (0.0055 per cent) > chlorfenapyr (0.0073 per cent) > thiodicarb (0.0190 per cent) > chlorpyriphos (0.0232 per cent) (Table 2 & Fig.2).

Results indicated that with reference to LC90, chlorantraniliprole was highly toxic to S. litura larvae with lowest LC90 (0.0150 per cent) followed by chlorfenapyr, thiodicarb and chlorpyriphos with LC90 values 0.0201, 0.0420 and 0.0679 per cent, respectively. It is evident from the data that chlorantraniliprole, chlorfenapyr and thiodicarb were showed 4.52, 3.37 and 1.61 times toxic over chlorpyriphos. The order of relative toxicity based on LC90 values in the descending order was chlorantraniliprole (0.0150) > chlorfenapyr (0.0201) > thiodicarb (0.0420) > chlorpyriphos (0.0679).

Table 1: Toxicity of test insecticides against *S. litura* by leaf dip method at 72 hours after exposure.

Insecticide	Heterogeneity (χ2) (D. f - 5)	Slop ± S.E (b)	Regression equation (Y= a + bX)	LC_{50} (%)	FL (95% CI)	LC_{90} (%)	FL (95% CI)
Chlorantraniliprole	0.881	2.479 ±0.067	Y= 10.752+2.476X	0.0055	0.0039-0.0067	0.0150	0.0114-0.0194
Chlorfenapyr	0.919	2.855 ±0.061	Y= 08.231+2.855X	0.0073	0.0056-0.0095	0.0201	0.0152-0.0262
Chlorpyriphos	0.999	2.778 ±0.060	Y= 09.542+2.778X	0.0232	0.0176-0.0305	0.0679	0.0516-0.0894
Thiodicarb	0.968	3.586 ±0.046	Y= 07.231+3.586X	0.0190	0.0155-0.0233	0.0420	0.0343-0.0515

Table 2: Relative toxicity of test insecticides against *S. litura* by leaf dip method at 72 hours after exposure

S.NO	Insecticide	LC_{50} (%)	Relative toxicity	LC_{90} (%)	Relative toxicity
1	Chlorantraniliprole	0.0055	4.21	0.0150	4.52
2	Chlorfenapyr	0.0073	3.17	0.0201	3.37
3	Chlorpyriphos	0.0232	1.0	0.0679	1.0
4	Thiodicarb	0.0190	1.22	0.0420	1.61

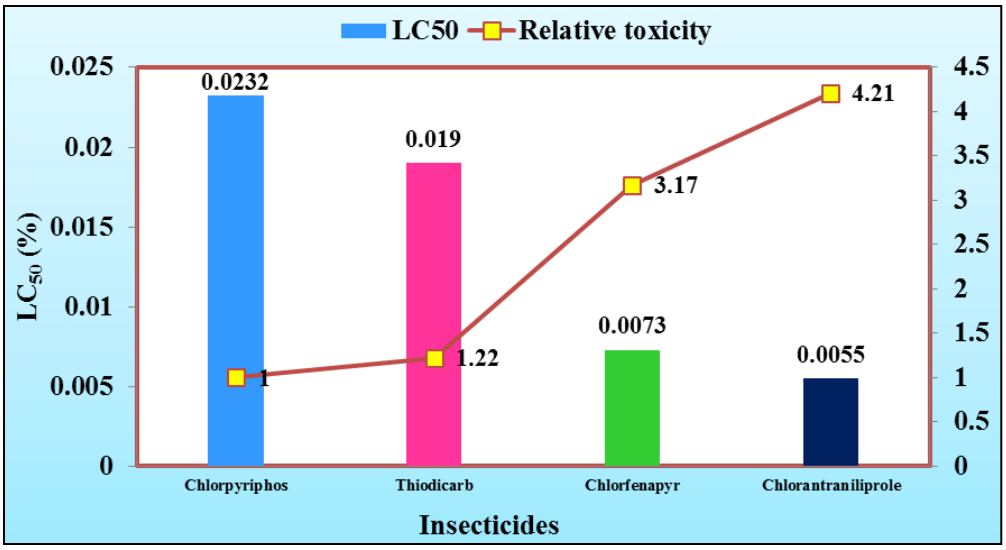

Fig 1: Relative toxicity of test insecticides against Rangareddy population of *Spodoptera litura* over chlorpyriphos with reference to (LC_{50})

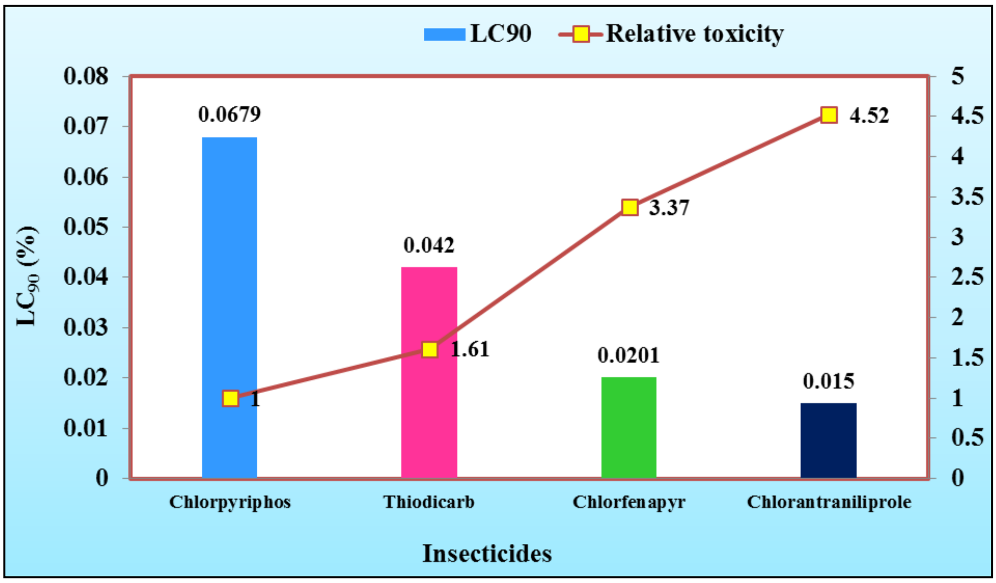

Fig 2: Relative toxicity of test insecticides against Rangareddy population of *Spodoptera litura* over chlorpyriphos with reference to (LC_{90})

Discussion

Chlorantraniliprole

Results of the present investigation are in accordance with Dhawan *et al*. (2007) [5] who have evaluated toxicity of chlorantraniliprole against S. litura population with LC50 value of 0.0044 per cent. Kumar and Acharya (2015) [6] reported that chlorantraniliprole was the most potent insecticide against S. litura with an LC50 value of 0.0047 per cent. Similarly Karupaiah and Srivastava (2013) [7] and Kanth *et al*. (2016) [8] reported that chlorantraniliprole was found to be the most toxic insecticide with least LC50 value of 0.0001, 0.001 per cent by leaf dip method. The reason for toxicity, it might be due to the novel insecticide, activates the unregulated release of internal calcium stores leading to calcium depletion, feeding cessation, muscle paralysis and finally insect death Lahm *et al*. 2007 [9].

Chlorfenapyr

Results of chlorfenapyr was in accordance with the results of Lingaraj *et al*. (2009) [10] who reported that chlorfenapyr was most toxic with least LC50 value of 0.0084 per cent. Quan *et al*. (2003) [11] reported that the higher toxicity of chlorfenapyr against fourth instar larvae of S. exigua was 125 ppm. Adamczyk *et al*. (1999) [12] also reported second instar larvae of Spodoptera frugipedra being more susceptible to chlorfenapyr than thiodicarb. Darabian and Yarahmadi (2017) [13] reported that chlorfenapyr was the potent insecticide to control S. exigua which has significantly decreased the number of eggs and larval population.

Thiodicarb

These results are in accordance with the results of Lingaraj *et al*. (2009) [10] who reported that thiodicarb was effective insecticide in controlling the third instar larvae of S. litura with LC50 value of 0.0292 per cent. Similarly Natikar and Balikali (2015) [14] reported toxicity against thiodicarb against third instar larvae of S. litura as 279.29 ppm by leaf dip method. Saini *et al*. (2005) [15] evaluated 13 insecticides for their efficacy against S. litura and concluded that thiodicarb was best giving 100 per cent kill of the larvae within 24 hours.

Chlorpyriphos

Present results were in accordance with the reports of Chauhan and Srivastava (2015) [16] who reported efficacy of chlorpyriphos against S. litura LC50 as 0.017 per cent.

Similarly Natikar and Balikali (2015) [14] reported toxicity of chlorpyriphos against third instar larvae of S. litura was 143.84 ppm by leaf dip method. Suvarna *et al*. (2013) [17] reported that chlorpyriphos showed toxicity against Rangareddy and Nalgonda populations with LC50 values of 0.030 and 0.062 per cent, respectively. Dhawan *et al*. (2007) [5] reported that chlorpyriphos was most toxic insecticide against S. litura with LC50 value of 0.039 per cent.

Among the four insecticides tested, chlorantraniliprole was found to be most toxic with least LC50 value (0.0055%) followed by chlorfenapyr, thiodicarb and chlorpyriphos. The order of toxicity based on LC50 values was chlorantraniliprole (0.0055%) > chlorfenapyr (0.0073%) > thiodicarb (0.019%) and chlorpyriphos (0.0232%) respectively, and chlorantraniliprole, chlorfenapyr and thiodicarb showed 4.21, 3.17 and 1.22 times toxic over chlorpyriphos at 72 hours after exposure.

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