World Journal of Zoology 4 (4): 277-280, 2009
ISSN 1817-3098

Toxicity of Ivermectin in Inducing Larval Mortality in *Ailanthus* Webworm, *Atteva fabriciella* Swederus (Lepidoptera: Yponomeutidae)

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Abstract: Insecticidal activity of ivermectin (Ivecop-12), a derivative of avermectin B produced by a soil actinomycete, *Streptomyces avermitilis*, was evaluated in laboratory against the larvae of *Atteva fabriciella* Swederus, a key defoliator of *Ailanthus excelsa* Roxb. (family Simaroubaceae). The study was conducted thrice with eight treatment concentrations of lethal and sub-lethal doses. Results revealed that ivermectin is highly toxic and induce larval mortality when applied on host plant leaves and larvae together of the insect pest. Toxicity of the tested product was found to be effective at a very low level and knock-down toxicity was noticed to be very rapid. Among the concentrations of ivermectin tested, cent percent mortality was recorded by the higher treatment concentrations of 1.2, 0.6, 0.3 and 0.15% and significantly ($P<0.05$-$P<0.01$) different from other treatments of lower concentrations including control. Further, there was a gradual decline of larval mortality in respect of lowering concentrations of the ivermectin. The dosage effect was found to be conclusive ($P<0.05$-$P<0.01$). The LC_{50} value of the tested product was worked out to be 0.023903% against the target insect pest.

Key words: *Ailanthus excels* · *Atteva fabriciella* · Ivermectin · Toxicity · Lethal concentrations · LC_{50}

INTRODUCTION

Ailanthus excelsa Roxb. (family Simaroubaceae), commonly known as *Maharukh* or *Mahaneem*, is one of the promising fast growing multipurpose tree species (MPTS) in India [1]. *Ailanthus* webworm, *Atteva fabriciella* Swederus (Lepidoptera: Yponomeutidae), is a major insect pest of this potential tree species causing large scale defoliation in nurseries and plantations [2,3]. As a result of repeated defoliation, the growth of the tree is severely retarded, young plants are badly weakened and ultimately seed formation is drastically reduced owing to the damage caused to inflorescence [4,5]. Unequivocal studies have been made on the biology, life cycle and ecology of this insect [6-8]. Apart from the work of Singh and Gupta [9], Meshram and Jamaluddin [10] and Roychoudhury *et al*. [11] on evaluation of chemical pesticides, Joshi *et al*. [12] on bioassay of varietal toxins of *Bacillus thuringiensis* and, Kulkarni and Joshi[13] on antifeedant effects of some botanical extracts, information on the effective control measures of this defoliator is very scanty indeed. Therefore, the present study has been undertaken to examine the sensitivity and response of *A. fabriciella* to ivermectin, developed from avermectins that represent a novel class of natural compounds with potent pesticidal activities, produced by a soil actinomycete, *Streptomyces avermitilis* MA-4680 (NRRL 8165) [14]. There is a dearth of literature about the toxicity of the product in context to leaf feeding insects.

MATERIALS AND METHODS

Larvae of *A. fabriciella* were collected from the heavily infested trees of *A. excelsa*, planted in and around Jabalpur (Madhya Pradesh) and were bred in the insectary of this Institute. Fresh leaves of host plants were provided daily to insects as food. One day old last instar larvae of weight ranged from 0.045-0.055 g (mean 0.051± 0.003 g) were separated out and preconditioned by starvation for about one hour.

The desired concentrations of ivermectin (Ivecop-12, manufactured by Oshin Laboratories Pvt. Ltd., Kundli, Haryana and marketed by Shalaks Pharmaceuticals Pvt. Ltd., New Delhi) were prepared in laboratory by dissolving in distilled water. Water emulsion or solution was then uniformly sprayed separately on host plant leaves containing preconditioned 10 larvae of *A. fabriciella* by hand atomizer. The sprayed host plant

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leaves and larvae were then transferred to clean marked beaker of one litre capacity lined at the bottom with a piece of filter paper and covered with muslin cloth. Similarly, the untreated host plant leaves and larvae served as control. In all, three replications of each concentration were made. The observations on the number of dead and moribund larvae after 24, 48 and 72 hours of treatment were recorded. The experiment was repeated thrice. The data on larval mortality recorded after 72 hours of treatment were subjected to ANOVA (CRD) after angular transformation to conform to normal distribution [15] for each trial. The data of each trial and pooled data of three trials were also evaluated and corrected by using Abbott's formula [16] and subjected to probit analysis [17] with some modifications [18] for calculation of LC_{50} value of the insecticide tested. The experiments were conducted in laboratory under the prevailing environmental conditions varied from 35-39°C and the relative humidity 43-49% in April 2009.

RESULTS AND DISCUSSION

The percentage larval mortality occurred in the present study due to treatment of different concentrations of ivermectin against *A. fabriciella* in three trials is summarized in Table 1. On the basis of three trials made against the target pest, results exhibited larval mortality due to treatment of ivermectin, when applied on host plant leaves and larvae together, which was significantly ($P<0.05$-$P<0.01$) different among their mean values ($F=79.636$, $P<0.01$; d.f. 8, 18 for Trial I; $F=115.266$, $P<0.01$; d.f. 8, 18 for Trial II; $F=136.924$, $P<0.01$; d.f. 8, 18 for Trial III). Among the eight concentrations of ivermectin tested, cent percent mortality was recorded by the higher treatment concentrations of 1.2, 0.6, 0.3 and 0.15% and significantly ($P<0.05$-$P<0.01$) different from other treatments of lower concentrations including control. The dosage effect was found to be conclusive ($P<0.05$-$P<0.01$). Further, there was a gradual decline of

Table 1: Data (mean) on percentage mortality of larvae in *A. fabriciella* obtained due to treatment of ivermectin in laboratory

Treatment concentration (%)	Indices	Larval mortality (%) Trial I (22.04.2009)	Trial II (26.04.2009)	Trial III (30.04.2009)	Pooled mean
1.2	T1	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
0.6	T2	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
0.3	T3	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
0.15	T4	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
0.075	T5	86.67 (68.86)	90.00 (71.57)	76.67 (61.22)	84.45 (67.22)
0.0375	T6	70.00 (57.00)	73.33 (59.00)	56.67 (48.85)	66.67 (54.95)
0.01875	T7	46.67 (42.99)	56.67 (48.93)	40.00 (39.15)	47.78 (43.69)
0.009375	T8	20.00 (26.07)	30.00 (33.00)	13.33 (21.14)	21.11 (26.74)
Control*	T9	6.67 (12.29)	3.33 (6.14)	6.67 (12.29)	5.56 (10.24)
SEm	3.390	2.818	2.693	2.967	
C.D. at 1%	13.798	11.470	10.961	12.076	
C.D. at 5%	10.072	8.372	8.001	8.815	

*Without any treatment.

Angular transformed values are inside parentheses.

Table 2: Toxicity of ivermectin against the larvae of *A. fabriciella* in laboratory

Trial	Regression equation	Heterogeneity	Degrees of freedom	LC_{50}	Fiducial limits
I (22.04.2009)	Y=1.492+2.547x	÷2 =1.265	3	0.023840	0.018931
					0.030022
II (26.04.2009)	Y=2.924+1.743x	÷2 =2.134	3	0.015525	0.010652
					0.022628
III (30.04.2009)	Y=1.708+2.213x	÷2 =3.523	3	0.030731	0.023753
					0.039758
Pooled mean	Y=1.751+2.357x	÷2 =1.672	3	0.023903	0.021128
					0.030442

Y = Probit kill. x = Log concentration, LC_{50}= Concentration calculated to give 50% mortality

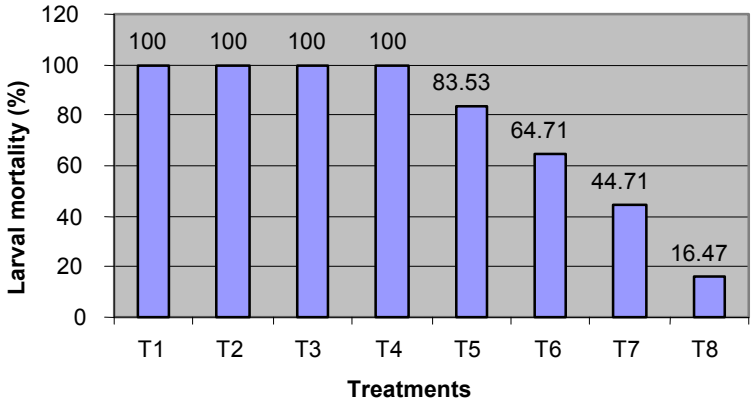

Fig. 1: Pooled data of percentage corrected larval mortality in *A. fabriciella* due to treatment of ivermectin

larval mortality in respect of lowering concentrations of the ivermectin as evident from the data of the three trials (Table 1) separately and also from pooled data based on percentage corrected mortality (Fig. 1).

The result of the probit analysis of the LC_{50} value of the tested ivermectin was worked out to be 0.023840, 0.015525 and 0.030731% against the insect pest for Trial I, II and III respectively. The LC_{50} value of pooled data of three trials was calculated as 0.023903% against the target pest. Earlier, Roychoudhury *et al*. [11] have recorded that on the basis of LC_{50} values, the highly toxic and most effective insecticide against the tested insect is cypermethrin (0.00198%), followed by fenvalerate (0.00256%), monocrotophos (0.01957%), acephate (0.01971%) and malathion (0.03557%). On the basis of a field trial made by Meshram and Jamaluddin [10], it has been reported that control of the present insect may be achieved by applying 0.02% monocrotophos.

The present findings clearly suggest the toxic properties of the tested ivermectin against the larvae of *A. fabriciella* and possess potent insecticidal activities at very low concentrations when compared with chemical pesticides. It has been reported that synthetic chemical studies following the discovery of the avermectins produced by a soil actinomycete, *S. avermitilis* during the process of fermentation, led to the synthesis of ivermectin, a semisynthetic avermectin [19]. Ivermectin is the common name for 22, 23-dihydroavermectin, produced commercially for veterinary and medical purposes [20]. Ivermectin has demonstrated broad spectrum activity against a variety of helminthic species [21] at a fraction of the concentrations of other antihelminthic compounds and currently used as a human drug for control of microfilaria that is transmitted by *Simulium* black flies [22]. The present study reports the insecticidal properties of ivermectin against phytophagous insect.

There is no published information regarding toxicity of tested product against the larvae of *A. fabriciella*, with which the present findings could be compared. Therefore, the data on LC_{50} of the product recorded in the present work can be employed profitably for effective and economic use of ivermectin as a bio-insecticide against *A. fabriciella* and as guide-lines for future investigations.

ACKNOWLEDGEMENTS

Author is grateful to Dr. A.K. Mandal, Director, Tropical Forest Research Institute, Jabalpur-482021 (M.P.), for providing necessary research facilities to carry out this work under the ICFRE intramural research project, entitled "Studies on the efficacy of toxins of soil actinomycetes against major forest insect pests" [ID No. 103/TFRI/2006/Ento-2(13)].

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