

**OVICIDAL AND LARVICIDAL TOXICITY OF VARIOUS INSECTICIDES
AGAINST *Spodoptera litura* Fabricius ON CABBAGE**

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ABSTRACT

A laboratory trial was conducted to determine the relative toxicity of various insecticides against eggs and larvae of S. litura on cabbage. Among the different insecticides evaluated against S. litura for their ovicidal toxicity revealed that profenophos + cypermethrin 0.017 per cent was found to be the best treatment, which gave the higher egg mortality (90.49 %) and it was at par with spinosad 0.025 per cent (87.50%). The bio-efficacy of various insecticides against larvae of S. litura revealed that higher larval mortality by leaf dip method was recorded in the treatment with spinosad @ 0.025 per cent (87.49%). The second effective treatment was profenophos 40 % + cypermethrin 4% @ 0.017 per cent (80.49%), which was also superior over rest of the treatments except spinosad 45 SC @ 0.025 per cent. The bio-efficacy of various insecticides against larvae of S. litura revealed that the higher larval mortality by topical application was recorded in the treatment with emamectin benzoate @ 0.025 per cent, which gave the maximum 90.50 per cent mortality and it was at par with spinosad @ 0.025 per cent (87.49%).

KEY WORDS: *Cabbage, larvicidal, ovicidal, S. litura, toxicity*

INTRODUCTION

Spodoptera litura Fabricius is an important lepidopterous, noctuid, polyphagous and multivoltine pest. It has worldwide distribution and cosmopolitan in food habit, feeding on the plants of economic importance. The larvae of *S. litura* have been reported to feed on 112 cultivated crops all over the world (Moussa *et al.*, 1960). Besides cabbage, this pest is known to cause heavy losses to tobacco, castor, groundnut, tomato and other agricultural crops, which proves its tremendous polyphagous nature (Atwal, 1986). The damage is done by larval stage and is often serious. Cabbage as a vegetable crop harvested at rather short intervals and often consumed as raw

without much processing. Besides this, the excessive use of only chemical insecticides has also been criticized for their deleterious effects like development of insecticide resistance in insects and pest resurgence. *S. litura* has been reported to show higher level of resistance against many of the insecticides used in the country. Hence, it was necessitate to use the newer chemical insecticides or biopesticides against *S. litura* (Ramkrishnan *et al.*, 1984).

MATERIALS AND METHODS

Ovicidal toxicity

A laboratory trial was conducted at Department of Entomology, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar in Completely

Randomized Design repeated thrice times with eleven treatments. Three sets of glass slides (7.5 x 2.5 mm) consist of 10 eggs in each slide were taken (one set as one repetition) for each insecticidal treatment. A set of 10 freshly laid eggs glued on slide and were allowed to dry for some time. Spray of respective insecticides was applied by using baby spray and these glass slides were kept individually in Petri dish (10 x 2.5 cm). Eggs without treatment were kept as untreated control (check). The treated eggs were observed daily under microscope till all the eggs hatched out in untreated control (up to 7 days). Observations on number of eggs hatched were recorded daily up to 7 days. The egg mortality per cent was calculated as per the Abbott's (1925) formula.

Larvicidal toxicity

A laboratory trial was also conducted at Department of Entomology, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, in Completely Randomized Design repeated thrice times with eleven treatments following leaf dip method and topical application method..

Leaf dip method

The required concentrations of various insecticides were prepared in one liter water. For the larvicidal action of different insecticides, 10 larvae in each treatment were fed with the cabbage leaves dipped into spray solution for one minute of each treatment. Each larva kept in separate plastic container (5 x 3.5 cm) covered with perforated lid. Fresh food of cabbage leaves was provided to live larvae every day. The observations on larval mortality was recorded at 24, 48 and 72 hours after treatment and worked out per cent mortality in each treatment as per the formula suggested by Abbott (1925).

Topical application

For this purpose, fresh cabbage leaves were collected from the unsprayed plots and washed thoroughly with distilled

water. Such leaves were placed individually in Petri dish (9.0 x 1.0cm). Laboratory reared larva of *S. litura* were used as test insect. Ten larvae of *S. litura* were placed carefully on cabbage leaf. Commercially available formulations of test insecticides were sprayed with the help of atomizer on larvae of *S. litura* in laboratory. Untreated control was kept as one treatment. Such cabbage leaves along with treated larvae were kept open in Petri dish for 30 minutes under ceiling fan and then covered Petri dish was kept at room temperature. The observations on larval mortality was recorded at 24, 48 and 72 hours after treatment and worked out per cent mortality in each treatment as per the formula suggested by Abbott (1925).

RESULTS AND DISCUSSION

Ovicidal toxicity

The results presented in Table 1 revealed that all the treatments found significantly superior in egg mortality of *S. litura* over untreated control (0.50%) except treatment with SNPV @ 250 LE/ha (2.45%). The maximum egg mortality was found in the treatment of profenophos 40% + cypermethrin 4% @ 0.017 per cent (90.49 %) and it was at par with spinosad 45 SC @ 0.025 per cent (87.50%). The next effective group of treatments was thiodicarb 75 WP @ 0.075 per cent (77.32%) and it was at par with indoxacarb 14.5 SC @ 0.007 per cent (70.49%). The treatment with indoxacarb 14.5 SC @ 0.007 per cent however, remained at par with emamectin benzoate 5 SG @ 0.025 per cent (67.23%). The emamectin benzoate 5 SG @ 0.025 per cent was also at par with rynaxypyr 20 SC @ 0.006 percent (60.50%). It was followed by neem oil @ 0.5 per cent (40.50%). Among rest of the treatments, *Bacillus thuringiensis* 5×10^7 spores/mg @ 0.2 per cent and *Beauveria bassiana* 2×10^8 cfu/gm @ 0.4 per cent recorded 10.50 per cent egg mortality. SNPV @ 250 LE/ha recorded 2.45 per cent eggs mortality, which could be natural mortality. Thus, it can be

concluded that, profenophos 40% + cypermethrin 4% was found significantly superior over rest of the treatments followed by spinosad 45 SC, which exhibited maximum mortality of *S. litura* eggs under laboratory conditions.

Panicker *et al.* (2003) reported that Polytrin C @ 0.088% (cypermethrin + profenophos) and endosulfan was most toxic insecticides to eggs of *S. litura*. Preetha *et al.* (2007) reported that in case of *S. litura*, maximum egg hatch inhibition was recorded by profenophos (87.34%) followed by thiodicarb (70.89%). The above reports are strongly in support of the present findings.

Larvicidal toxicity

Leaf dip method

After 24 hours of the treatment, the results revealed that treatment with spinosad 45 SC @ 0.025 per cent gave the maximum of 60.49 per cent mortality and it was at par with profenophos 40% + cypermethrin 4% @ 0.017 per cent (57.18%) and both were significantly superior over rest of the treatments (Table 2). It was followed by emamectin benzoate 5 SG @ 0.025 per cent (50.50%) and indoxacarb 14.5 SC @ 0.007 per cent (40.50%). The treatment with rynaxypyr 20 SC @ 0.006 per cent and thiodicarb 75 WP @ 0.075 per cent gave 27.02 and 23.68 per cent larval mortality, respectively and remained at par with each other and significantly superior over untreated control. The remaining non chemical treatments viz., neem oil @ 0.5 per cent, *Bacillus thuringiensis* 5×10^7 spores/mg @ 0.2 per cent, *Beauveria bassiana* 2×10^8 cfu/gm @ 0.4 per cent and SNPV @ 250 LE/ha did not show larval mortality after one day of application and remained at par with untreated control.

At 48 hours of the treatment, per cent mortality ranged from 0.50 to 80.49 per cent. The results presented in Table 2 revealed that all the treatments found significantly superior in larval mortality over untreated control (0.50%). The

treatment with spinosad 45 SC @ 0.025 per cent gave the maximum (80.49%) mortality and it was significantly superior over rest of treatments. The next effective treatments were profenophos 40% + cypermethrin 4% @ 0.017 per cent (73.98%) followed by emamectin benzoate 5 SG @ 0.025 per cent (70.50%) and indoxacarb 14.5 SC @ 0.007 per cent (60.50%). The treatments with rynaxypyr 20 SC @ 0.006 per cent and thiodicarb 75 WP @ 0.075 per cent recorded 50.50 and 47.15 per cent larval mortality, respectively and remained at par with each other and better effective than *Bacillus thuringiensis* 5×10^7 spores/mg @ 0.2 per cent (30.50%). Among rest of the treatments, neem oil @ 0.5 per cent and *Beauveria bassiana* 2×10^8 cfu/gm @ 0.4 per cent exhibited 23.68 and 20.50 per cent larval mortality, respectively and remained at par with each other and significantly superior over untreated control. SNPV @ 250 LE/ha recorded 16.87 per cent larval mortality, which was comparatively less effective than other insecticides, but was significantly superior over untreated control.

At 72 hours of the treatment, per cent larval mortality ranged from 0.50 to 87.49 per cent. The results presented in table 2 revealed that all the treatments found significantly superior over untreated control (0.50%). The treatment with spinosad 45 SC @ 0.025 per cent gave the maximum of 87.49 per cent mortality and it was significantly superior over rest of the treatments. The second effective treatment was profenophos 40 % + cypermethrin 4% @ 0.017 per cent (80.49%) which was also superior over rest of the treatments except spinosad 45 SC @ 0.025 per cent. The next effective group of treatments was emamectin benzoate 5 SG @ 0.025 per cent (73.98%) which was at par with indoxacarb 14.5 SC @ 0.007 per cent (70.50%). Indoxacarb 14.5 SC @ 0.007 per cent was however, at par with rynaxypyr 20 SC @ 0.006 per cent (63.90%) and

rynaxypyr 20 SC @ 0.006 per cent was also at par with thiodicarb 75 WP @ 0.075 per cent (57.20%). Treatments with neem oil @ 0.5 per cent (53.87%) and *Bacillus thuringiensis* 5×10^7 spores/mg @ 0.2 per cent (50.50%) found to be as effective as thiodicarb in larval mortality. *Beauveria bassiana* 2×10^8 cfu/gm @ 0.4 per cent (40.50%) and SNPV @ 250 LE/ha (30.50%) have also registered their efficacy and found significantly better than untreated control.

Thus, it can be concluded that, spinosad 45 SC was found significantly superior over rest of the treatments and gave maximum mortality of *S. litura* larvae under laboratory conditions by leaf dip method. Looking to the efficacy of non chemical pesticides neem oil and *Bacillus thuringiensis* were also found effective against larva of *S. litura*.

Kaur *et al.* (2011) tested *B. bassiana* against larvae of *S. litura* using three concentrations (2.03×10^8 , 4.03×10^6 and 1.47×10^5 spores/ml). All the treatments resulted in significantly higher mortality than control. Chitgupekar *et al.* (2013) reported that Spinosad @ 90 ppm and emamectin benzoate @ 6.25 ppm recorded 100 per cent *S. litura* larval mortality, followed by indoxacarb @ 158 ppm, which recorded mortality of 90 per cent at 72 h after treatment. The above reports are also in support to the present findings.

Topical application

The results presented in Table 3 revealed that all the chemical treatments showed significant difference in per cent mortality after 24 hours of the treatment, whereas biorational pesticides did not show any mortality. The per cent mortality ranged from 0.50 to 80.50 per cent. The treatment with emamectin benzoate 5 SG @ 0.025 per cent gave the maximum of 80.50 per cent mortality and it was at par with spinosad 45 SC @ 0.025 per cent (77.32%) and both were significantly superior over rest of the treatments. It was

followed by indoxacarb 14.5 SC @ 0.007 per cent (70.50%). The next effective treatment was rynaxypyr 20 SC @ 0.006 per cent (63.90%) and it was at par with profenophos 40% + cypermethrin 4% @ 0.017 per cent (60.50%) and both were significantly superior than thiodicarb 75 WP @ 0.075 per cent (50.49%). The remaining treatments viz., neem oil @ 0.5 per cent, *Bacillus thuringiensis* 5×10^7 spores/mg @ 0.2 per cent, *Beauveria bassiana* 2×10^8 cfu/gm @ 0.4 per cent and SNPV @ 250 LE/ha did not show larval mortality after one day of application and remained at par with untreated control (0.50%).

At 48 hours of the treatment, per cent mortality ranged from 0.50 to 87.49 per cent (Table 3). The results revealed that all the treatments found significantly superior in larval mortality of *S. litura* over untreated control (0.50). The treatment with emamectin benzoate 5 SG @ 0.025 per cent gave the maximum of 87.49 per cent mortality and it was significantly superior over rest of the treatments. The next best effective treatment was spinosad 45 SC @ 0.025 per cent (80.50%) and it was at par with indoxacarb 14.5 SC @ 0.007 per cent (77.32%). The treatment with indoxacarb 14.5 SC @ 0.007 per cent was also at par with rynaxypyr 20 SC @ 0.006 per cent (70.50%). The rynaxypyr 20 SC @ 0.006 per cent remained at par with profenophos 40% + cypermethrin 4% @ 0.017 per cent (67.23%). Profenophos 40% + cypermethrin 4% @ 0.017 per cent was at par with thiodicarb 75 WP @ 0.075 per cent (60.50%). Among the non chemical treatments, neem oil @ 0.5 per cent (20.50%) and *Bacillus thuringiensis* 5×10^7 spores/mg @ 0.2 per cent (16.87%) were found better than *Beauveria bassiana* 2×10^8 cfu/gm @ 0.4 per cent (13.52%) and SNPV @ 250 LE/ha (10.50%) in larval mortality. These treatments were less effective as compared to chemical insecticides but all were significantly superior to untreated control.

At 72 hours of the treatment, per cent mortality ranged from 0.50 to 90.50 per cent (Table 3). The results revealed that all the treatments were significantly superior in larval mortality over untreated control (0.50%). The maximum larval mortality was observed in emamectin benzoate 5 SG @ 0.025 per cent (90.50%) and it was at par with spinosad 45 SC @ 0.025 per cent (87.49%) and both were significantly superior over rest of the treatments. The next effective group of treatments was indoxacarb 14.5 SC @ 0.007 per cent (80.50%) and it was at par with rynaxypyr 20 SC @ 0.006 per cent (77.32%) and profenophos 40% + cypermethrin 4% @ 0.017 per cent (73.98%). Thiodicarb 75 WP @ 0.075 per cent exhibited 70.50 per cent mortality and remained at par with rynaxypyr 20 SC @ 0.006 per cent and profenophos 40% + cypermethrin 4% @ 0.017 per cent. Among rest of the treatments the per cent larval mortality in neem oil @ 0.5 per cent (33.75%) was at par with *Bacillus thuringiensis* 5×10⁷ spores/mg @ 0.2 per cent (30.50%) and *Beauveria bassiana* 2 × 10⁸ cfu/gm @ 0.4 per cent (27.02%). SNPV @ 250 LE/ha per cent recorded 23.68 per cent larval mortality, which was significantly superior over untreated control.

Thus, it can be concluded that, emamectin benzoate 5 SG was the best treatment over rest of the treatments and gave maximum larval mortality under laboratory conditions by topical application. Looking to the safety point of view, though non chemical pesticides exhibited lower mortality as compared with chemicals, but were significantly superior over untreated control. Thus, it can be utilized as an alternate to the chemicals in vegetable crops.

Prasad *et al.* (2007) described that emamectin benzoate was the most toxic against the *S. litura* followed by novaluron and indoxacarb. Sharma and Pathania (2012) reported that first instar larvae of *S.*

litura were highly susceptible to emamectin benzoate and indoxacarb when, tested by leaf dip and topical application methods. The above reports are strongly in support of the present findings.

CONCLUSION

The results clearly indicated that profenophos + cypermethrin 0.017 per cent was found to be the best ovicidal treatment, which gave the higher egg mortality. The higher larval mortality by leaf dip method was recorded in the treatment with spinosad @ 0.025 per cent (87.49%), whereas emamectin benzoate @ 0.025 per cent gave the maximum 90.50 per cent mortality of larvae of *S. litura* through topical application. Looking to the safety point of view, though non chemical pesticides exhibited lower mortality as compared with chemicals, but were significantly superior over untreated control. Thus, it can be utilized as an alternate to the chemicals in cabbage and other vegetable crops.

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Table 1: Ovicidal toxicity of various insecticides against *S. litura* under laboratory conditions

Sr. No.	Treatment	Concentration (%)	Egg Mortality (%)
1.	Profenophos 40% + Cypermethrin 4%	0.017	72.04 (90.49)
2.	Indoxacarb 14.5 SC	0.007	57.10 (70.49)
3.	Spinosad 45 SC	0.025	69.29 (87.50)
4.	Emamectin benzoate 5 SG	0.025	55.08 (67.23)
5.	Rynaxypyr 20 SC	0.006	51.06 (60.50)
6.	Thiodicarb 75 WP	0.075	61.56 (77.32)
7.	<i>Bacillus thuringiensis</i> 5×10 ⁷ spores/mg	0.2	18.90 (10.5)
8.	SNPV @ 250 LE/ha	-	9.00 (2.45)
9.	<i>Beauveria bassiana</i> 2 × 10 ⁸ cfu/gm	0.4	18.90 (10.5)
10.	Neem oil 1500 ppm	0.5	39.52 (40.5)
11.	Untreated control	-	4.05 (0.50)
S.E.m. ±			1.93
C.D. at 5 %			5.67
C. V. %			8.06

Arc sin transformed values, figures in the parenthesis are retransformed value.

Table 2: Larvicidal toxicity of various insecticides against *S. litura* under laboratory conditions by leaf dip method

Sr	Treatment	Concentration (%)	Per Cent Mortality After		
			24 Hour	48 Hour	72 Hour
1	Profenophos 40% + Cypermethrin 4%	0.017	49.13 (57.18)	59.33 (73.98)	63.79 (80.49)
2	Indoxacarb 14.5 SC	0.007	39.52 (40.50)	51.06 (60.50)	57.10 (70.50)
3	Spinosad 45 SC	0.025	51.06 (60.49)	63.79 (80.49)	69.29 (87.49)
4	Emamectin benzoate 5 SG	0.025	45.28 (50.50)	57.10 (70.50)	59.33 (73.98)
5	Rynaxypyr 20 SC	0.006	31.32 (27.02)	45.28 (50.50)	53.07 (63.90)
6	Thiodicarb 75 WP	0.075	29.12 (23.68)	43.36 (47.15)	49.13 (57.20)
7	<i>Bacillus thuringiensis</i> 5×10 ⁷ spores/mg	0.2	4.05 (0.50)	33.52 (30.50)	45.28 (50.50)
8	SNPV @ 250 LE/ha	-	4.05 (0.50)	24.25 (16.87)	33.52 (30.50)
9	<i>Beauveria bassiana</i> 2 × 10 ⁸ cfu/gm	0.4	4.05 (0.50)	26.92 (20.50)	39.52 (40.50)
10	Neem oil 1500 ppm	0.5	4.05 (0.50)	29.12 (23.68)	47.21 (53.87)
11	Untreated control	-	4.05 (0.50)	4.05 (0.50)	4.05 (0.50)
S.E.m. ±			0.90	1.67	1.68
C.D. at 5 %			2.65	4.91	4.94
C. V. %			4.90	7.03	6.21

Arc sin transformed value, figures in the parenthesis are retransformed value.

Table 3 :Larvicidal toxicity of various insecticides against *S. litura* under laboratory conditions by topical application.

Sr	Treatment	Concentration (%)	Per Cent Mortality After		
			24 Hour	48 Hour	72 Hour
1	Profenophos 40% + Cypermethrin 4%	0.017	51.06(60.50)	55.0(67.23)	59.33(73.98)
2	Indoxacarb14.5 SC	0.007	57.10(70.50)	61.56(77.32)	63.79(80.50)
3	Spinosad 45 SC	0.025	61.5(77.32)	63.79 (80.50)	69.29(87.49)
4	Emamectin benzoate 5 SG	0.025	63.7(80.50)	69.29 (87.49)	72.04(90.50)
5	Rynaxypyr 20 SC	0.006	53.0(63.90)	57.10 (70.50)	61.56(77.32)
6	Thiodicarb 75 WP	0.075	45.2(50.49)	51.06 (60.50)	57.10(70.50)
7	<i>Bacillus thuringiensis</i> 5×10 ⁷ spores/mg	0.2	4.05 (0.50)	24.25 (16.87)	33.52(30.50)
8	SNPV @ 250 LE/ha	-	4.05 (0.50)	18.90 (10.50)	29.12(23.68)
9	<i>Beauveria bassiana</i> 2 × 10 ⁸ cfu/gm	0.4	4.05 (0.50)	21.57 (13.52)	31.32(27.02)
10	Neem oil 1500 ppm	0.5	4.05 (0.50)	26.92 (20.50)	35.52(33.75)
11	Untreated control	-	4.05 (0.50)	4.05 (0.50)	4.05 (0.50)
S.Em. ±			0.90	1.67	1.68
C.D. at 5 %			2.65	4.91	4.94
C. V. %			4.90	7.03	6.21

Arc sin transformed value, figures in the parenthesis are retransformed value.