Indian Journal of Entomology Online published Ref. No. e21082 DoI.: 10.5958/IJE.2022.157

TOXICITY OF SOME INSECTICIDES TO LIFESTAGES OF *CHEILOMENES SEXMACULATA* UNDER LABORATORY CONDITIONS

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ABSTRACT

Commonly used insecticides in cowpea were evaluated for their safety to the aphidophagous predator *Cheilomenes sexmaculata* (F.). As per IOBC standards, acute toxicity bioassays done at recommended field doses showed that dimethoate was harmful to all the lifestages with 100% mortality. Thiamethoxam was found safe to egg stage but was harmful to grubs, pupae and adults. Neem oil was harmful to the non-feeding stages, eggs and pupae, completely inhibiting egg hatching and adult eclosion; it was harmless or slightly harmful to the feeding stages. Flubendiamide and spinosad were found harmless to all the lifestages with > 10% mortality (eggs, grubs and pupae) and 12.5% to adults.

Key words: *Cheilomenes sexmaculata*, lifestages, toxicity, dimethoate, thiamethoxam, spinosad, flubendiamide, neem oil, bioassays, safety

The IPM employs the combined use of physical, chemical, biological and other pest control options. The IPM framework uses these selectiveness (Garzon et al., 2015). Biocontrol offers the most sustainable and cost effective IPM and with supplemental insecticidal spray it can be more ecofriendly. The harmonious use of insecticides and biocontrol agents requires to be explored. Hence safety to the non-target organisms including natural enemies need to be studied. The mortality of these beneficial insects could result in poor natural regulation and resultant outbreak of insect pests (Shinde and Radadia, 2018). The six spotted zigzag ladybird beetle *Cheilomenes sexmaculata* (F.) is a common predator of pests in vegetable ecosystems. It is an effective predator of aphids and other sucking pests in different crops, but it is often undermined due to indiscriminate use of insecticides. Hence, understanding of acute toxicity of insecticides to its lifestages is needed. In the present study, the most commonly used insecticides in cowpea in Kerala have been evaluated for their toxicity to the lifestages of *C. sexmaculata.*

MATERIALS AND METHODS

The study was carried out from 2019 to 2020 at the Post Graduate Research Laboratory, Department of Agricultural Entomology, College of Horticulture, Vellanikkara. Culture of *Aphis craccivora* was maintained on cowpea plants raised in field and confined within cages of 2x 2 x 1.5 m size made of nylon mesh (120 micron size) to avoid any natural enemies and to facilitate population buildup of aphids. Aphids collected from these cowpea plants were used for rearing *C. sexmaculata.* Culture of *C. sexmaculata* was maintained in rearing cages (30x 30x 30 cm) containing aphid infested cowpea seedlings raised in containers @ five pairs/ cage. Eggs collected from rearing cages were used for experiments. Commercial formulation of five insecticides including a botanical (dimethoate 600 g a.i./ha, flubendiamide 25 g a.i./ ha, thiamethoxam 25 g a.i./ ha, spinosad 75 g a.i./ ha and neem oil at 3%- recommended in cowpea, as per Package of Practices Recommendations- POP Crops KAU, 2016) were evaluated.

One day old eggs of *C. sexmaculata* laid in cowpea leaves were dipped in prepared insecticide solutions for 10 sec (Khan et al., 2015). After draining of excess solution, the leaves were placed in petri dishes and observed for hatching. Each treatment was replicated four times with 10 eggs/ replication. The eggs were observed for hatching and survival of first instar grubs at 24 hr after hatching. Individually reared 0 to 24 hr old third instar grubs were released into petri dishes containing cowpea leaves inoculated with aphids at 10 grubs/ petri dish and were allowed to acclimatize for 2 hr. Insecticide solutions prepared at recommended doses were sprayed in these using hand atomizer, with spray droplets enough to wet the grubs, aphids and cowpea leaf. An untreated control was maintained using a spray of distilled water. Each treatment was replicated four times. Mortality of grubs was recorded

at 12, 24, 48 and 72 hr after spraying. 0 to 24 hr old pupae were dipped in insecticidal solution for 10 sec. The dipped pupae were placed on tissue paper to drain excess insecticide solution and then transferred to petri dishes @ 10 pupae/ petri dish. An untreated control was maintained by dipping pupae in distilled water. Each treatment was replicated four times. Treated pupae were observed for adult emergence and survival of adults at 24 hr after emergence.

Ten numbers of one day old adult beetles were released into petri dishes with cowpea leaf inoculated with aphids and left undisturbed for 2 hr. The adult beetles were exposed to treatments using a hand atomizer. Each treatment was replicated four times. An untreated control was maintained by spraying with distilled water. Mortality of adults was recorded at 12, 24, 48 and 72 hr after spraying.

RESULTS AND DISCUSSION

As given in Table 1, neem oil and dimethoate were observed to be highly toxic to egg stage of *C. sexmaculata* as none hatched; such highly toxic nature of neem oil (1%) to eggs was shown Khan et al. (2015). This mortality is attributed to the adherence of oil particles to the chorion that terminates respiration (da Silva, 2004). Neem extract as harmless to eggs of *C. septempunctata* was observed by Kaethner (1991), which is a contradiction to present findings. The ovicidal effect of dimethoate (0.03%) on eggs was observed by Shanmugapriya and Muralidharan (2017). Tank et al. (2007) observed only 42% mortality with dimethoate 0.015%. Eggs treated with thiamethoxam though recorded 77.5% hatching, only 41.93% of the hatched grubs survived after 24 hr. Shanmugapriya and Muralitharan (2017) observed 77.1% mortality of eggs with thiamethoxam (0.005%). Sanghani et al. (2018) observed 24% mortality of eggs with thiamethoxam (0.01%).

Flubendiamide and spinosad were harmless to eggs with 77.5 and 85% hatching, with relatively higher survival of 93.65 and 93.93%, respectively that were on par with control. Spinosad (0.05%) as slightly toxic with 47% mortality of eggs was observed by Khan et al. (2015), in contrast with 15% observed now. Dimethoate caused significantly higher mortality of 62.5% followed by thiamethoxam with 27.50% in 0-24 hr old third instar grubs. A gradual increase in mortality was observed both in dimethoate and thiamethoxam reaching 100 % at 48 and 72 hr, respectively. Similar trend of mortality was observed with thiamethoxam and dimethoate by

Table 1. Effect of insecticides on survival of *C.sexmaculata*

Treatment	Egg hatchability (%)	Survival of grubs/ adults at 24 hr after hatching		Cumulative mortality (%) of third instar grubs at different hours after treatment				Adult emergence (%)	Survival of emerged adults at 24 hr after emergence		Cumulative mortality (%) of one day old adults at different hours after treatment			
		Numbers survived	Survival (%)	12h	24h	48h	72h		Numbers survived	Survival (%)	12h	24h	48h	72h
		Eggs and grubs									Adults			
Dimethoate	0^{e}	-	-	62.50^{a}	90.00^{a}	100.00^{a}	-	0.00^{e}	-	-	87.50^{a}	92.50^{a}	100.00^{a}	-
	(0.91)			(52.49)	(73.96)	(89.09)		(0.91)			(72.25)	(78.30)	(89.09)	
Flubendiamide	77.50^{b}	7.25	93.54^{a}	7.50^{e}	7.50^{e}	10.00^{bc}	10.00^{e}	90.00^{a}	8.25	91.67^{a}	10.00^{cd}	12.50^{d}	12.50^{e}	12.50^{e}
	(62.15)		(79.39)	(14.05)	(14.05)	(16.09)	(16.09)	(76.26)		(77.44)	(16.09)	(20.47)	(18.18)	(18.18)
Thiamethoxam	77.50^{b}	3.25	41.93^{b}	27.50^{b}	67.50^{b}	92.50^{a}	100.00^{a}	17.50^{b}	0	0.00^{b}	70.00^{b}	80.00^{b}	97.50^{a}	100.00^{a}
	(62.15)		(40.42)	(31.39)	(55.50)	(78.30)	(89.10)	(24.16)		(0.91)	(56.95)	(63.81)	(84.71)	(89.09)
Neem oil	0.00^{e}	-	-	10.00^{e}	10.00^{e}	15.00^{b}	32.50^{b}	0.00^{e}	-	-	20.00^{e}	37.50^{e}	45.00^{b}	50.00^{b}
	(0.91)			(16.09)	(16.09)	(22.50)	(34.50)	(0.91)			(26.19)	(37.66)	(42.05)	(45.00)
Spinosad	85.00^{ab}	8	94.11^{a}	5.00^{cd}	7.50^{e}	7.50^{bc}	7.50^{e}	92.50^{a}	8.75	94.60^{a}	5.00^{d}	10.00^{d}	12.50^{e}	12.50^{e}
	(70.22)		(79.13)	(9.67)	(14.05)	(14.05)	(14.05)	(78.30)		(80.07)	(9.67)	(16.09)	(18.18)	(18.18)
Control (Water dip)	92.50^{a}	9	97.29^{a}	0.00^{d}	2.50^{e}	5.00^{e}	5.00^{e}	95.00^{a}	9.25	97.36^{a}	2.50^{d}	5.00^{d}	5.00^{e}	5.00^{e}
	(75.95)		(84.45)	(0.91)	(5.29)	(7.32)	(7.32)	(82.68)		(84.71)	(5.29)	(9.67)	(9.67)	(11.70)
CD (p=0.05)	11.84	-	12.29	12.04	13.88	14.19	12.39	14.88	-	11.96	14.01	13.16	12.12	11.37

* In vertical columns, means followed by same letter do not differ significantly by DMRT, P =0.05; Figures in parentheses arc sine transformed values

Shanmugapriya and Muralidharan (2017). The present results with dimethoate agree with those of Tank et al. (2007) who categorized dimethoate (0.015%) as highly toxic. Neem oil, though recorded only 10% mortality at 12 hr, it gradually increased to 15% at 48 and 32.5% at 72 hr. This harmless nature of neem oil observed now is in line with that of Khan et al. (2015). Flubendiamide and spinosad were harmless to grub stage (7.5 and 5% mortality respectively at 12 hr); mortality increase to only 10 and 7.5%, respectively till 72 hr, which was on par with control. Khan et al. (2015) found spinosad as slightly toxic to third instar grubs, with 50% mortality which is in contrast with present results.

No adults emerged from pupae treated with neem oil as well as dimethoate, and only 17.5% adult emergence was observed from pupae treated with thiamethoxam. Thus, these three insecticides were categorized as harmful to pupae as per IOBC evaluation protocol. Harmful nature of neem oil to pupae of *C. sexmaculata* is in accordance with the observations of Khan et al. (2015), that maximum mortality of pupae was observed with only 13.3% adult emergence; same authors with spinosad found it as harmless to pupal stage with 60% adult emergence. Flubendiamide resulted in 90% adult emergence and was rated safe to the pupae.

Dimethoate caused mortality of 87.5% to adults followed by thiamethoxam (70%) at 12 hr; mortality gradually increased to 100% at 48/ 72hr, with dimethoate/ thiamethoxam- thus, as per IOBC protocol, these are harmful. The results of Basappa (2007) confirms the present findings; toxicity of dimethoate is also in conformity with earlier reports of Tank et al. (2007) and Megha et al. (2014). In contrast, a recent study by Sanghani et al. (2018) observed only 33.3% mortality with thiamethoxam (0.01%) but following a different method of exposure by releasing the test insects in sprayed surface.

Neem oil, though recorded only 20% mortality at 12 hr, it gradually increased to 50% at 72 hr and thus was rated as slightly harmful. Varied results with neem products had been recorded- Megha et al. (2014) observed 100% mortality with nimbicidine (0.5%) at 12 hr and Khan et al. (2015) observed 22% mortality with neem oil (1%) at 48 hr in adults. Flubendiamide and spinosad were harmless (12.5% mortality of adults at 72 hr which was on par with control mortality of 5%. Spinosad was thus harmless to adults, and these results agree with those of Jalali et al. (2009) with adults of *Adalia bipunctata* and that of Galvan et al. (2005) with adults of *H. axyridis.*

ACKNOWLEDGEMENTS

This work was conducted as part of Post Graduate research in Kerala Agricultural University. The authors acknowledge the support provided by the Kerala Agricultural University.

REFERENCES

Basappa H. 2007. Toxicity of biopesticides and synthetic insecticides to egg parasitoid, *Trichogramma chilonis* Ishii and coccinellid predator *Cheilomenes sexmaculata* (Fab.). Journal of Biological Control 21(1): 31-36.

da Silva F A and Martinez S S. 2004. Effect of neem seed oil aqueous solutions on survival and development of the predator *Cycloneda sanguinea* (L.) (Coleoptera: Coccinellidae). Neotropical Entomology 33(6): 751-757.

Galvan T L, Koch R L, and Hutchison W D. 2005. Effects of spinosad and indoxacarb on survival, development, and reproduction of the multicolored Asian lady beetle (Coleoptera: Coccinellidae). Biological Control 34(1): 108-114.

Garzon A, Medina P, Amor F, Viñuela E, and Budia F. 2015. Toxicity and sublethal effects of six insecticides to last instar larvae and adults of the biocontrol agents *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) and *Adalia bipunctata* (L.) (Coleoptera: Coccinellidae). Chemosphere 132: 87- 93.

Jalali M A, Leeuwen T V, Tirry L, and De Clercq P. 2009. Toxicity of selected insecticides to the two-spot ladybird *Adalia bipunctata*. Phytoparasitica 37: 323-326.

Kaethner M. 1991. No side effects of neem on the aphidophagous predators *Chrysoperla carnea* and *Coccinella septempunctata*. Anz Schaed Pflanz Umwel 64: 97-99.

KAU [Kerala Agricultural University]. 2016. Package of practices recommendations: Crops, (15th ed.). Kerala Agricultural University, Thrissur, 44p.

Khan S, Ullah F, Khan I, Khan M A, Khan S. Z, Khan M A, Khan I A, and Iqbal T. 2015. Toxicity of selected insecticides against the zig zag ladybird beetle *Menochilus Sexmaculatus*. Journal of Zoological Studies 3(3): 143-147.

Megha R. R, Basavangoud K, and Kulkarni M S. 2014. Safety evaluation of some insecticide against coccinellids, *Cheilomenes sexmaculata* (Fab.) and *Hippodamia varigata* (Goeze). Journal of Experimental Zoology India 18(20): 315-318.

Sanghani N J, Bhanderi G R, and Desai H R. 2018. Relative toxicity of commonly used pesticides to different stages of predator *Cheilomenes sexmaculata* (Fabricius) in cotton. Entomon 43(1): 67-70.

Shanmugapriya V and Muralidharan C M. 2017. Evaluation of chemical Evaluation of chemical insecticides and botanicals for its toxicity to *Cheilomenes sexmaculatus* Fabricius. International Journal of Chemical Studies 5(3): 150-152

Shinde C U and Radadia, G G. 2018. Field persistent toxicity of various insecticides against potent predator, *Cheilomenes sexmaculata* (F.). International Journal of Chemical Studies 6(1): 87-91.

Tank B D, Korat D M, and Borad P K. 2007. Relative toxicity of some insecticides against *Cheilomenes sexmaculata* (Fab) in laboratory. Karnataka Journal of Agricultural Sciences 20(3): 639- 641.

(Manuscript Received: June, 2021;
Revised: September, 2021;
Accepted: September, 2021;
Online Published: February, 2022)
Online published (Preview) in www.entosocindia.org
Ref. No. e21082