International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(6): 1707-1711

Received: 06-09-2017
Accepted: 07-10-2017

Repalle Naganna
Department of Agricultural Entomology, N. M.C. A., Navsari Agricultural University, Navsari, Gujarat, India

Shinde Cu
Department of Agricultural Entomology, N. M.C. A., Navsari Agricultural University, Navsari, Gujarat, India

Correspondence
Repalle Naganna
Department of Agricultural Entomology, N. M.C. A., Navsari Agricultural University, Navsari, Gujarat, India

Relative toxicity of various insecticides against ecto-larval parasitoid, *Goniozus nephantidis* (Muesebeck) (Bethylidae: Hymenoptera) of Coconut black headed caterpillar, *Opisina arenosella* Walker

Repalle Naganna and Shinde Cu

Abstract
The study on relative toxicity of different insecticides against *G. nephantidis* revealed that there was no insecticide under testing found totally safe except control treatment (water spray) to the adults of *G. nephantidis*. However, spinosad 45 SC was comparatively harmless to the adults. Moreover, indoxacarb 15.8 per cent EC, emamectin benzoate 5 per cent SG, quinalphos 25 per cent EC, flubendiamide 39.35 per cent EC and profenofos 50 per cent EC were slightly harmful. Furthermore, triazophos 40 per cent EC, dichlorvos 76 per cent EC and chlorpyriphos 20 per cent EC were moderately harmful, while none of insecticide was categorized as harmful to the adults of *G. nephantidis* under laboratory conditions.

Keywords: Relative toxicity, *Goniozus nephantidis*, Insecticides, etc

Introduction

The coconut palm, *Cocos nucifera* L. belongs to family Arecaceae is “Tree of Life” as well as “*Kalpa vriksha*” provides livelihood to billions of people across the world. The coconut palm is infested by a number of insect pests. Among them, *Opisina arenosella* Walker causes the severe damages to the foliage, depriving the palm of its photosynthetic area and thus, directly affecting the yield (Sujatha and Chalam, 2009) [22]. The black headed caterpillar, *O. arenosella* is one of the serious and endemic pest of coconut in India (Cock and Perera, 1987) [5] and Gurav *et al*., 2014) [13]. The black headed caterpillar is attacked by many entomophagous insects during its developmental stages. Among them, *G. nephantidis* is a gregarious larval parasitoid and responsible for the reduction in the population pest under field conditions (Cock and Perera, 1987) [5]. Intensive and successive foliar applications of broad spectrum chemical insecticides for controlling larval stages leads to environmental pollution, in addition to the relation between the insect resistance development and the natural balance disturbance (Ekrem *et al*., 1996) [10]. The integrated use of natural enemies and different selective pesticides appear possible to management the crop pests and conserve the parasitoids (Dora *et al*., 2004) [9]. Pesticide intervention is considered essential in some situations to control high infestations of specific pests so as to reduce economic damage and pest spread to healthy orchard. Selective insecticides that target pest species could play a major role in conserving this wide diversity of natural enemies associated with crop (Gnanadhas, *et al.*, 2010) [12]. Improved understanding of pest-natural enemy and insecticides interaction would assist in formulating more effective Integrated Pest Management strategies in coconut ecosystem. Use of pesticides which are incompatible with natural enemies has caused some adverse effects such as target pest resurgence, secondary pest outbreaks and reduction in non-target organisms (Fariba and Effat, 2015) [11]. The evaluation of the impact of various insecticides on *G. nephantidis* is important to promote integrated pest management of *O. arenosella*. Therefore, the present investigation was conducted to know the relative safety of various insecticides against *G. nephantidis* under laboratory conditions with field concentrations.

Material and Methods

To determine the relative toxicity of different insecticides against adults of *G. nephantidis*, the adults were obtained from laboratory culture and they were used in susceptibility test to different insecticides during the year 2015-16 at Bio-control Laboratory, Department of Entomology, N.M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat).

Method of insecticidal application

The insecticides were evaluated for their safety to the parasitoid. Contact toxicity of insecticides was determined as per methodology suggested by Jalali and Singh (1993) [15]. A transparent plastic vials (7x2.5 cm) with a plastic lid converted into a pesticide-testing unit by making a small holes in middle of lid to avoid fumigant effect of insecticides and to provide aeration.

The prepared solution of insecticide was sprayed on all inner sides of vials and lid with an atomizer and both were then air-dried thoroughly. In control treatment, only water spray was done. Ten newly emerged adults of *G. nephantidis* were introduced per treatment per repetition individually into plastic vials and exposed to treated surface freely for about 45 minutes. Thereafter, adults were transformed to fresh plastic vial containing Corcyra larvae. The honey solution 50 per cent diluted was provided in the form of fine streak on wax coated paper stripes.

Method of observations

Observations on the mortality of *G. nephantidis* adults were recorded at 12, 24, 48 and 72 hours after. The data obtained on per cent adult mortality of *G. nephantidis* converted into arc sine transformation values and then subjected to statistical analysis. The magnitude of the response of toxicant exposure on the parasitoid, *G. nephantidis* was subjected to classify as per International Organization for Biological Control (IOBC) toxicity rating (Sterk *et al*., 1999) [21]. For laboratory trials, IOBC employs a following scale to categories the tested insecticides. Thus, the same scale was employed in present investigation to differentiate the evaluated insecticides into various groups of toxicity.

Toxicity rating for natural enemies		
Score	**Adult mortality (%)**	**Toxicity categories**
1	<25% mortality	Harmless
2	25-50% mortality	Slightly harmful
3	51-75% mortality	Moderately harmful
4	>75% mortality	Harmful

Results and Discussion

The data in terms of percentage of mortality recorded at 12, 24, 48 and 72 hours after insecticidal application are presented in Table-01 and depicted in Figure 1 to 2, and discussed as hereunder.

The perusal of the mortality data obtained at 12 hrs after treatments indicated that no adult mortality was recorded in control treatment (water spray). The treatment of spinosad 0.002 per cent recorded the lowest adult mortality (6.67%) which was at par with flubendiamide 0.0096 per cent (10.00%) and indoxacarb 0.01 per cent (10.00%). The treatment of profenofos 0.075 per cent, emamectin benzoate 0.0025 per cent and quinalphos 0.05 per cent had equal adult mortality (20.00%). Moreover, remaining insecticides *viz*., chlorpyriphos 0.05 per cent, triazophos 0.05 per cent and dichlorvos 0.05 per cent showed 23.33, 26.67 and 43.33 per cent adult toxicity, respectively.

It can be seen from the data obtained at 24 hrs that no adult mortality occurred in control treatment (0.00%). The treatment of spinosad 0.002 per cent showed lowest mortality (16.67%) which was statistically at par with flubendiamide 0.0096 per cent (23.33%) and it was followed by indoxacarb 0.01 per cent (26.67%), profenofos 0.075 per cent (26.67%), emamectin benzoate 0.0025 per cent (33.33%), quinalphos 0.05 per cent (36.67%), chlorpyriphos 0.05 per cent (40.00%), triazophos 0.05 per cent (43.33%) and dichlorvos 0.05 per cent (56.67%).

The data on per cent adult mortality at 48 hrs after treatment indicated that treatment of spinosad 0.002 per cent exhibited minimum adult mortality (20.00%). This was followed by flubendiamide 0.0096 per cent (30.00%), indoxacarb 0.01 per cent (36.67%), profenofos 0.075 per cent (43.33%), emamectin benzoate 0.0025 per cent (53.33%) and quinalphos 0.05 per cent (56.67%). The toxicity of remaining insecticides in ascending order was chlorpyriphos 0.05 per cent (63.33%) < triazophos 0.05 per cent (76.67%) < dichlorvos 0.05 per cent (83.33%).

At 72 hrs after exposure, control treatment recorded no any adult mortality. This was followed by spinosad 0.002 per cent (26.67%) and flubendiamide 0.0096 per cent (40.00%). The toxicity of remaining insecticides in ascending order was indoxacarb 0.01 per cent (46.67%) < profenofos 0.075 per cent (63.33%) < emamectin benzoate 0.0025 per cent (66.67%) < quinalphos 0.05 per cent (73.33%) < chlorpyriphos 0.05 per cent (93.33%) except triazophos 0.05 per cent and dichlorvos 0.05 per cent exhibited cent per cent adult mortality.

Pooled analysis of the data revealed that all treatments under the investigation showed significant mortality to adults of *G. nephantidis* except control treatment (0.00%). Moreover, the treatment of spinosad 0.002 per cent17.50%) was at par with flubendiamide 0.0096 per cent (25.83%) and indoxacarb 0.01 per cent (30.00%) and it was followed by profenofos 0.075 per cent (38.33%), emamectin benzoate 0.0025 per cent (43.33%), quinalphos 0.05 per cent (46.67%), chlorpyriphos 0.05 per cent (55.00%), triazophos 0.05 per cent (61.67%) and dichlorvos 0.05 per cent (70.83%).

The ascending order of toxicity of different insecticides to adults of *G. nephantidis* were spinosad 0.002 per cent < flubendiamide 0.0096 per cent < indoxacarb 0.01 per cent < profenofos 0.075 per cent < emamectin benzoate 0.0025 per cent < quinalphos 0.05 per cent < chlorpyriphos 0.05 per cent < triazophos 0.05 per cent < dichlorvos 0.05 per cent. The ANOVA of pooled analysis of data on per cent adult mortality over period revealed that the interaction (Period x Treatment) was found to be non-significant indicating consistent performance of various treatments over period of observation. Based on the pooled data, the ranking to the various insecticides were made and presented Table-02.

From the above all results, it is ascertained that there was no insecticide under testing found totally safe except control treatment (water spray) to the adult of *G. nephantidis.* However, spinosad 45 per cent SC was comparatively harmless to the adults. Moreover, indoxacarb 15.8 per cent EC, emamectin benzoate 5 per cent SG, quinalphos 25 per cent EC, flubendiamide 39.35 per cent SC and profenofos 50 per cent EC were slightly harmful. Moreover, the treatment of triazophos 40 per cent EC, dichlorvos 76 per cent EC and chlorpyriphos 20 per cent EC were moderately harmful, while none of insecticide was grouped as harmful to the adults of *G. nephantidis*.

Table 1: Relative toxicity of different insecticides against adults of *G. nephantidis* under laboratory conditions (2015-16)

Treat. No.	Treatment detail	Conc. (%)	Mean per cent mortality at different intervals				Pooled	Toxicity Rating
			12 HAT	24 HAT	48 HAT	72 HAT		
T_1	Indoxacarb 15.8% EC	0.01	18.42b (10.00)	30.98c (26.67)	37.20cd (36.67)	43.05c (46.67)	32.41 bcd (30.00)	2
T_2	Emamectin benzoate 5% SG	0.0025	26.55c (20.00)	35.20de (33.33)	46.90e (53.33)	54.76d (66.67)	40.85 cde (43.33)	2
T_3	Chlorpyriphos 20% EC	0.05	28.76c (23.33)	39.21ef (40.00)	52.75f (63.33)	77.50e (93.33)	49.55 ef (55.00)	3
T_4	Quinalphos 25% EC	0.05	26.55c (20.00)	37.20 ef (36.67)	48.82ef (56.67)	58.98d (73.33)	42.88 de (46.67)	2
T_5	Flubendiamide 39.35% SC	0.0096	18.42b (10.00)	28.76bc (23.33)	33.19c (30.00)	39.21c (40.00)	29.89 bc (25.83)	2
T_6	Spinosad 45% SC	0.002	12.45b (6.67)	23.84b (16.67)	26.55b (20.00)	30.98b (26.67)	23.45 b (17.50)	1
T_7	Profenofos 50% EC	0.075	26.55c (20.00)	30.98cd (26.67)	41.13d (43.33)	52.75d (63.33)	37.85 cd (38.33)	2
T_8	Dichlorvos 76% EC	0.05	41.13d (43.33)	48.82g (56.67)	66.11g (83.33)	89.44f (100.00)	61.37 g (70.83)	3
T_9	Triazophos 40% EC	0.05	30.98c (26.67)	41.13f (43.33)	61.19g (76.67)	89.44f (100.00)	55.68 fg (61.67)	3
T_{10}	Control (Water spray)	-	0.91a (0.00)	0.91a (0.00)	0.91a (0.00)	0.91a (0.00)	0.91a (0.00)	1
S. Em ± (T)			2.21	1.93	1.77	2.39	4.02	--
(PxT)			-	-	-	-	2.09	
C.D. at5% (T)			6.53	5.71	5.22	7.05	11.68	
(PxT)			-	-	-	-	NS	
C.V. (%)			16.66	10.59	7.40	7.72	9.68	
Figures outside the parentheses are arcsine transformed values while those inside are original values; HAT: Hours After Treatment								

Table 2: Safety ranking to the various insecticides against *G. nephantidis* under laboratory conditions

Score	Category	Perceived insecticides
1	Harmless (<25% mortality)	Spinosad 45% SC
2	Slightly harmful (25-50% mortality)	Indoxacarb 15.8% EC, Emamectin benzoate 5% SG, Quinalphos 25% EC, Flubendiamide 39.35% SC, Profenofos 50% EC
3	Moderately harmful (51-75% mortality)	Triazophos 40% EC, Dichlorvos 76% EC, Chlorpyriphos 20% EC
4	Harmful (>75% mortality)	Nil

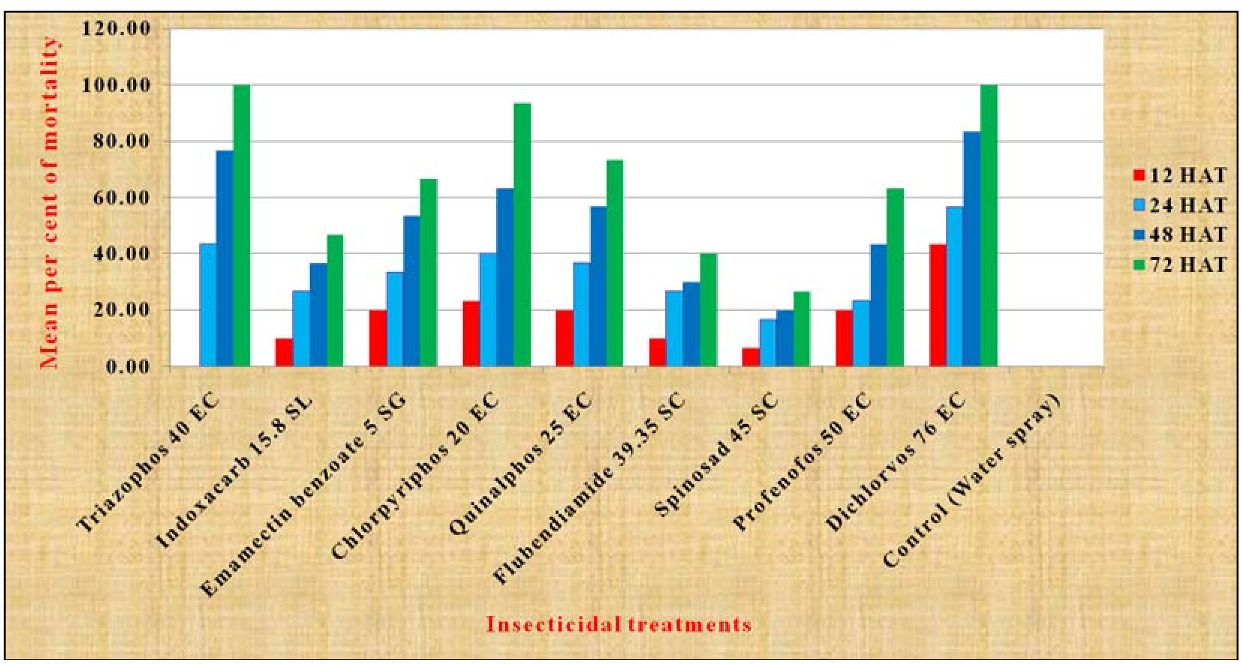

Fig 1: Relative toxicity of different insecticides against adults of *G. nephantidis* under laboratory conditions

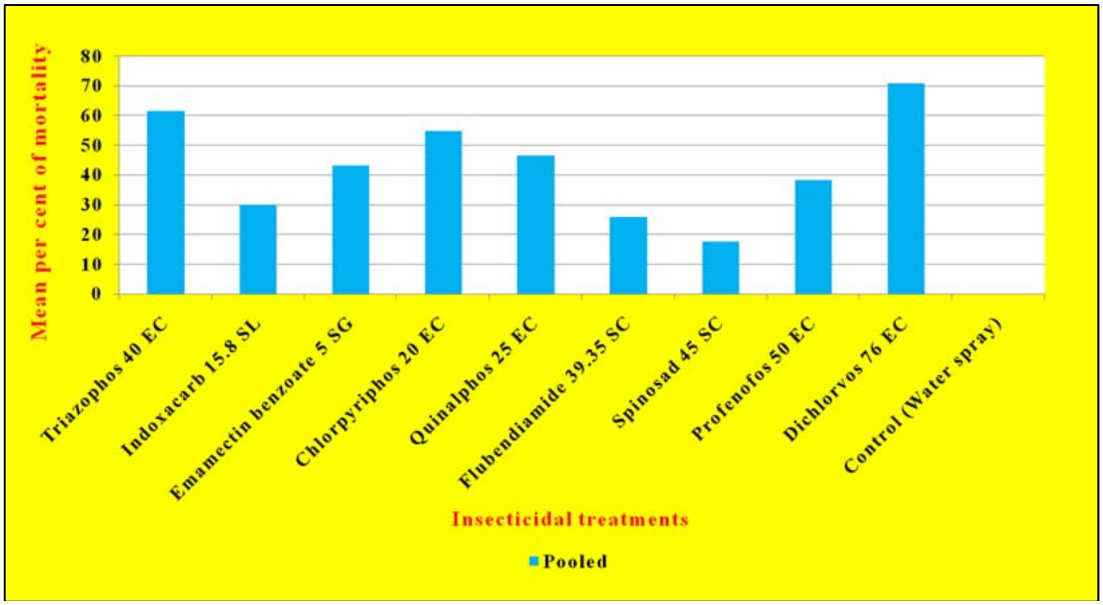

Fig 2: Relative toxicity of different insecticides against adults of *G. nephantidis* under laboratory conditions (Pooled)

Present findings are more or less in accordance with the findings of past workers *viz*., Sundaramurthy (1980) [23] recorded more or less similar observations and revealed that diflubenzuron was applied once at 2.5 to 20g ai/10 litres of water to coconut palms found safer against to *Perisierola nephantidis* Mues. Whereas, Bhushan and Azam (1990) [3] who reported that the deltamethrin was the most toxic insecticide to both parasitoids *viz*., *G. nephantidis* and *B. hebetor* at 0.0000926 and 0.0000626 per cent LC_{50} value, respectively and it was followed by cypermethrin (0.000107 and 0.0000693%), permethrin (0.000284 and 0.000820%) and fenvalerate (0.000505 and 0.000126%). Among the tested insecticides, monocrotophos 0.04 per cent and chlorpyriphos 0.04% per cent were very toxic to all the stages of *B brevicornis*, *G. nephantidis* and *T. pupivora* under laboratory condition (Patil *et al*., 1990) [18].

The present findings are in conformity with the results reported by Dhawan (2000) [7] who noted that the quinalphos (500g ai/ha), chlorpyriphos (1000g ai/ha) and chlorpyriphos methyl (1000g ai/ha) were found more toxic to the larvae of *Chrysoperla carnea* (Stephens) and recorded 90.7 to cent per cent mortality. Later on, Srinivasan and Sundarababu (2000) [20] indicated that the quinalphos 0.05 per cent was toxic to larvae of *C. carnea.* Consoli *et al.* (2001) [6] who noticed that the lufenuron (15 g ai/100 litre water), triflumuron (25 g ai/100 litre water) and spinosad (48 g ai/100 litre water) were harmful and tebufenozide (12 g ai/100 litre water) was harmless to *Trichogramma galloi* Zucchi which differed with the present investigation on spinosad as it was harmless to adults of *G. nephantidis*. However, Abida *et al.* (2004) [1] who found that *Bacillus thuringiensis,* spinosad, thiodicarb and indoxacarb exhibited safety to adults of *T. chilonis* and *C. carnea* which disagreed with above worker as it existed as slightly harmful to adults of *G. nephantidis.* Varghese and Beevi (2004) [24] reported that chlorpyriphos had the lowest LC_{50} value i.e. 0.0017 and found to be the most toxic to larvae of *C. carnea,* while triazophos found less toxic (LC_{50} 0.0349) which not in support to present finding as triazophos 40 EC found more toxic to adults of *G. nephantidis* and caused the highest mortality. Rashad *et al.* (2005) [19]. reported that the chlorpyrifos 40 EC and profenofos 50 EC were found to be the most toxic to the adults of *B. hebetor* and present investigation revealed that profenofos 50 EC had slightly toxic to adults of *G. nephantidis*. According to Nalini and Manickavasagam (2011) [17], profenofos caused cent per cent mortality within 1 hour in both *Aenasius bambawalei* (Hayat) and *Aenasius advena* (Compere) and it was slightly corroborated with present findings. The present investigation are agreed with Ahmad *et al.* (2012) [2] who reported that the spinosad 0.01 per cent showed less toxicity to the *T. chilonis* in oviposition preference.

The present investigations are akin to findings of Hooshang *et al.* (2012) [14] who suggested that the indoxacarb had slightly toxic to *H. hebetor*. Chaturvedi (2014) [4] reported that the chlorpyriphos 50 per cent EC noted as harmful to *Carcella illota* (Curran). The present findings are in line with Karthik *et al.* (2015) [16] who observed that the least mortality of *C. blackburni* adults was exhibited in the lower dose of emamectin benzoate 5 SG (7 g a.i/ha) which showed 13.33, 23.33 and 33.33 per cent mortality at 6, 12 and 24 HAT, respectively and spinosad at 75 g a.i/ha registered the mortality percentage of 36.67, 46.67 and 56.67 at 6, 12 and 24 HAT, respectively. Dilbar *et al*. (2015) [8] reported that the emamectin benzoate, lufenuron, and imidacloprid were found safer to *T. chilonis* and recorded more than 50 per cent adult emergence. The findings of above workers support the present investigation while discrepancy in relative toxicity of various insecticides against adults of *G. nephantidis* perhaps might be due to variation in test insect, tested insecticides, food on which the host insect reared, adopted methodology for their investigation and prevailing ecological conditions.

Conclusion

From the above all results, it can be concluded that there was no insecticide under investigation found totally safe except control (water spray) to the adults of *G. nephantidis.* However, spinosad 45 per cent SC was comparatively harmless to the adults. While none of insecticide was categorized as harmful to the adults of *G. nephantidis.* It is inferred that the none of the insecticides can be considered completely safe for *G. nephantidis*. Nevertheless, release of parasitoids would be considered appropriate only after 72 hours of application of insecticides on coconut plantation. However, in view to minimize of the possible detrimental effects of these pesticides on *G. nephantidis*, the use of these products should be considered with utmost care for IPM of coconut black headed caterpillar.

Acknowledgement
Authors are sincerely thankful to the Director of Research and Dean PG studies, NAU, Navsari for providing the necessary facilities to execute the research. Authors are grateful to the Principal and Dean, N. M. College of Agriculture, NAU, Navsari for providing necessary facilities during the course of investigation.

References

1. Abida N, Ghulam M, Muhammad A, Mushtaq AA. Combined Effect of *Chrysoperla carnea* Stephen (Neuroptera: Chrysopidae) and *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae) on *Helicoverpa armigera* Eggs in the Presence of Insecticides. Pakistan J. Zool. 2004; 36(3):189-191.
2. Ahmad URS, Mehreen N, Abid F, Imtiaz AK. Compatibility of Spinosad with *Trichogramma chilonis* (Ishii) (Hymenoptera: Trichogrammatidae) in Integrated Pest Management of Sitotroga cereallela. Pakistan J. Zool. 2012; 44(1):133-139.
3. Bhushan VS, Azam KM. Toxicity of synthetic pyrethroids to larval parasites of coconut black headed caterpillar, Opisina arenosella. Indian Coconut Journal (*Cochin)*. 1990; 20(9):10-12.
4. Chaturvedi I. Observations on comparative efficacy of insecticides against, *Carcella illota* and Bacillus thuringiensis. International Journal of Research in Biosciences. 2014; 3(1):1-6.
5. Cock MJW, Perera PACR. Biological control of *Opisina arenosella* Walker (Lepidoptera: Oecophoridae). Coconut Research Institute of Sri Lanka. B.N.I. 1987; 8:283-309.
6. Consoli FL, Botelho PSM, Parra JRP. Selectivity of insecticides to the egg parasitoid Trichogramma galloi Zucchi, 1988, (Hym., Trichogrammatidae). J Appl. Ent. 2001; 125:37-43.
7. Dhawan AK. Impact of some new insecticides on natural enemy complex of cotton ecosystem. Pestology. 2000; 24(4):8-14.
8. Dilbar H, Hussain A, Muhammad Q, Juma K. Insecticidal Susceptibility and Effectiveness of *Trichogramma chilonis* as Parasitoids of Tomato Fruit Borer, Helicoverpa armigera. Pakistan J Zool. 2015; 47(5):1427-1432.
9. Dora IP, Juan C, Olivia H, Trevor W. Lethal and sub lethal effects of the naturally derived insecticide Spinosad on parasitoids of *S. frugiperda* (Lepidoptera: Noctuidae). Biocontrol Sci. and Technol. 2004; 15(1):81-95.
10. Ekrem A, Moshe C, David R. Within plant distribution of Thrips and their Predators: Effects of cotton variety and developmental stage. Department of Entomology. Fac. Agric., Univ. of Çukurova, Turkey. 1996; 86(6):45-49.
11. Fariba S, Effat A. Effect of pesticides used in tomato fields of Iran on the egg parasitoid *Trichogramma brassicae* (Hymenoptera: Trichogrammatidae) under laboratory conditions. Biological Forum – An International Journal. 2015; 7(2):975-980.
12. Gnanadhas P, Thiyagarajan M, Johnson S, Sasthakutty K. Impact of chloronicotinyl insecticide, imidacloprid on egg, egg-larval and larval parasitoids under laboratory conditions. Journal of Plant Protection Research. 2010; 50(4):536-540.
13. Gurav SS, Khandekar RG, Sawant VS, Narangalkar AL. Scenario of coconut pests in Konkan Region of Maharashtra. International Journal for Research in Emerging Science and Technology. 2014; 1(4):61-62.
14. Hooshang RD, Mehdi H, Gadir NG, Ali G, Somaye S. Sub lethal effects of indoxacarb, imidacloprid and deltamethrin on life table parameters of *Habrobracon hebetor* (Hymenoptera: Braconidae) in pupal stage treatment. J Crop Prot. 2012; 1(3):221-228.
15. Jalali SK, Singh SP. Susceptibility of various stages of Trichogrammatoidea armigera Nagaraja to some pesticides and effect of residues on survival and parasitising ability. Biocontrol Sci. and Tech. 1993; 3:21-27.
16. Karthik P, Kuttalam S, Gunasekaran K, Thangachamy P. *In vitro* safety of emamectin benzoate 5 SG to Chelonus blackburni (Cameron). Life Sciences Leaflets. 2015; 70:37- 42.
17. Nalini T, Manickavasagam S. Toxicity of selected insecticides to mealy bug parasitoids, *Aenasius bambawalei* Hayat and *Aenasius advena* Compere (Hymenoptera: Encyrtidae). Journal of Biological Control. 2011; 25(1):14-17.
18. Patil RK, Lingappa S, Basappa H. Effect of insecticides and a chitin inhibitor on development of three parasitoids of the coconut black headed caterpillar *Opisina arenosella* Walker, Journal of Oilseeds Research. 1990; **7**(2):51-57.
19. Rashad RK, Muhammad A, Shahnaz AR. Some studies on the toxicity of conventional and new chemistry insecticides against *Bracon hebetor* say (Hymenoptera: Braconidae) under laboratory conditions. Pak. Entomol. 2005; 27(19):19-21.
20. Srinivasan G, Sundarababu PC. Toxicity of certain insecticides to predatory green lacewing, *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae). J Biol. Control. 2000; 14(1):5-7.
21. Sterk G, Hassan SA, Baillod M, Bakker F, Bigler F, Blumel S *et al*. Results of the seventh Joint Pesticides Testing Programme carried out by the IOBC/WPRS working group pesticides and beneficials. Biocontrol. 1999; 44:99-117.
22. Sujatha A, Chalam MSV. Status of coconut Black headed Caterpillar, Opisina arenosella Walker and evaluation of bio-agents. Annals of Plant Protection Sciences. 2009; 17(1):65-68
23. Sundaramurthy VT. Effects of diflubenzuron on a field population of the coconut black headed caterpillar, *Nephantis serinopa* Meyrick (Lepidoptera: Gelechiidae) and its parasite, *Parasierola nephantidis* (Muesebeck) (Hymenoptera: Bethylidae), in India. Bulletin of Entomological Research. 1980; 70(1):25-31.
24. Varghese B, Beevi SN. Safety of insecticides to the green lacewing, *Chrysoperla carnea* (Stephens). Insect Environment. 2004; 10(1):45-47.