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RESEARCH ARTICLE

BEHAVIOURAL STUDY OF *TRICHOGRAMMA CHILONIS* ISHII TO THE SELECTED CHEMICALS ON TREATED HOST EGGS OF CORCERYA *CEPHALONICA*

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ABSTRACT

Experiments were carried out to test the effects of chemicals on different behavioural activities of *T.chilonis* females on the treated *Corcerya cephalonica* eggs was recorded the video for 10 minutes (600sec) and analyzed by using Observer® XT software developed by Noldus technology. The results showed that among the six insecticides and one antibiotic with the doses (LD50, half of LD50 and one fourth of LD50) tested, all the pesticides were negatively effects the behavioural activities of *T.chilonis* females, except only chlorantraniliprole pesticide and sublethal (lower) doses of Spinosad @ 0.0045% and streptomycine sulphate @ 0.000375% found harmless. The oviposition of *T. chilonis* females on treated *C. cephalonica* eggs was found in the lethal dose of chlorantraniliprole@ 0.006% and sublethal doses of 0.003%, 0.015%with mean duration of 211.3sec, 223.3secand230sec.The oviposition activity in the sublethal doses of spinosad @ 0.0045% and streptomycine sulphate @ 0.000375%with mean duration of 208.6sec and 226.4sec it was found that significantly lower than control. Thenon- ovipositional activities of *T. chilonis* females only found maximum in the remaining chemicalswhich suggested that *T. chilonis* females were trying to avoid the host treated site and escape.

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INTRODUCTION

Trichogramma chilonis Ishii belong to genus Trichogramma (**fy**: Trichogrammatidae, **od**: Hymenoptera). The parasitoidsarefirst collected by Ishii (1941) from the eggs of *chilo simplex* Butler and Diatraea species on rice plants near Los Banas, Laguna, Philippines. It has been reared and released for controlling several lepidopteran insect pests on corn (*Zea mays* L.), cotton and vegetables (Chang *et al.,* 2001; Ballal*et al.,* 2009; Preetha *et al.,* 2009). It is most widely used in integrated pest management programmes (Jalali *et al.,* 2006). The intensive use of pesticides to control multiple pest problems reduces the action of *T. chilonis*. Many laboratory and field studies have showed that highly susceptible to most broad-spectrum pesticides (Bull and Coleman, 1985). Pesticide impact on non-target insects includeslethal and sublethal effects (physiological and behaviour) (Desneux *et al*., 2007; Stark and Banks, 2003). The negative effect of pesticidesonovipositional behaviour of *T. chilonis* females on the host eggs treated with different insecticides showed that reduction in oviposition preference by spinosad 240 % SC, 120.0 mg a.i. L^{-1}>emamectin 1.9% EC, 3.2 mg a.i. L^{-1}>lufenuron 50% EC, 83.3 mg a.i.L^{-1}>indoxacarb 150% EC, 186.7 mg a.i. L^{-1}>flubendiamide 480% SC, 80.0 mg a.i. L^{-1} treated eggs (Satter *et al*., 2011). In majority of studies, the compatibility of a pesticide with biological control agents is often examined by tests screening for mortality of natural enemies, but sublethal effects on beneficial insects are largely overlooked (Elzen, 1989) and scarce information. The present investigation to find thenegative effects of selected pesticideson different behavioural activities of *T. chilonis* females and also screen the harmless pesticides with different sublethaldoses.

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MATERIALS AND METHODS

Tested chemicals

Total selected six insecticides andone antibiotic with three lethal and sublethalconcentrations (LD_{50}, half of LD_{50} and quarter of LD_{50}) were used. The experiments were divided in

four sets on the basis of chemical group of tested insecticides (Table-1)
A) Neonicotinoids and bacterial based insecticide
B) Organophosphate and anthranilic diamide insecticide
C) Antibiotic
D) Botanical pesticide.

Methodology

The following experiment method is developed by adopting method described by the Nurindah and Bronwen, (1997) to find out thenegative effects of selected pesticideson behavioural activities of *T.chilonis* females. Sixteen eggs of *C. cephalonica* was arranged in 4 x 4 matrix on egg card. The egg card was treated with the predefined treatment (Table 1). Then egg card was offered to one-day old female of *T. chilonis* to oviposit for 10 minutes. The whole episode of female behavioural activity was recorded from release of female on egg card till the female rested, approx. 15 minutes. The video tracking system attached on bino stereo zoom microscope was used for record the episode. The various events (host searching, host examination, oviposition, resting, circling, walking, grooming) recorded were analyzed by using Observer® XTcomputer software program developed by Noldus technology Bv Netherlands. The following observations was calculated and analyzed with the help of software.

Observations recorded

Ovipositional behaviours

a. **Searching:** Female searching the egg in a egg patch by drumming frequently with the antennae near the egg
b. **Examination:** Female moving around the surface on the host egg by tapping her antennae upward and downward on egg surface.
c. **Oviposition:** Female penetrate ovipositor into a host egg by a series of distinct abdominal movements.

Non- ovipositional behaviours

a) **Walking:** Female moves towards or away from the egg patch in the arena by moving her antennae
b) **Circling:** Female moves around the circumferences of closed arena
c) **Grooming**: Female clean her body appendages i.e. antennae, wings and abdomen with the help of legs.
d) **Resting:** Pausing activities in between oviposition activity

RESULTS AND DISCUSSION

The results of different behavioral activities showed by the *T. chilonis* females on various chemicals doses of treatedcorcerya eggs were recorded the video for 10 minutes and analyzed using Observer® XT computer software program developed by Noldus technology Bv Netherlands and data on time allotted to each behavior activity were obtain

Effect of neonicotinoids and bacterial based insecticides on behavioursof *T. chilonis*

The ovipositional activities of *T. chilonis* females on treated corcerya eggs was restricted in all three insecticides treatments, except the sublethal dose of spinosad @ 0.0045% (Table 2 and Fig. 1). The oviposition activity of *T. chilonis* females was observed in the sublethal dose of spinosad @ 0.0045%with mean duration of 208.6sec, it was found significantly lower than control. The non-ovipositional activates were observed in all three insecticides. The circling (escaping) behaviouris only found on the treated corcerya eggs sitesof imidacloprid treatmentswith mean duration of 600sec.The circling and walking behavior is found in the treated sites of thiamethoxam treatments with the duration range of (422-500sec)and (100-178sec). The circling activity was highly profound in all three insecticides suggested that *T. chilonis* was tried to escape from the treated site.

Effect of organophosphate and anthranilicdiamide insecticide on behaviours of *T. chilonis*

The ovipositional activities of *T. chilonis* females on treated corcerya eggswas restricted in the all doses of profenophoswhereas all oviposition activities were found in the chlorantraniliprole treatments (Table 3 and Fig 2).The non-ovipositional activities like circling, walking found in the treated sites of profenophos treatments with the duration range of (268-488.3sec), (31-332sec) and the grooming (80.6 sec)found in the dose of profenophos @ 0.1%.The circling activity was highly profound in all treatments of profenophos suggested that *T. chilonis* females was rejected the oviposition site and escape. The ovipositional activities like searching, examination found on the treated sites of chlorantraniliprole treatments with the duration range of (9.3sec-24sec), (72.6-96sec) and the oviposition (211.3-230sec) was found significantly lower than control.

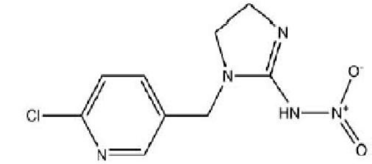
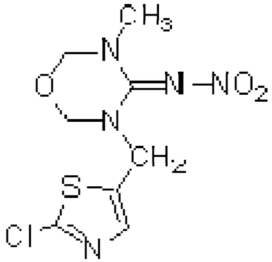
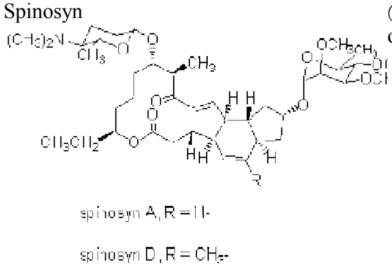
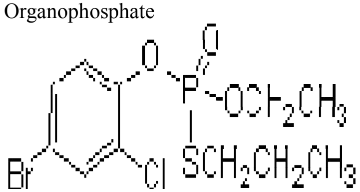
Effect of antibioticon behaviours of *T. chilonis*

The ovipositional activities of *T. chilonis* females on treated corcerya eggs was restricted in the lethal dose @ 0.0015% and sublethal dose @ 0.00075% of streptomycin sulphate treatmentswhereas all oviposition activities were found in thesublethaldose @ 0.00375% (Table 4 and Fig 3). The non-ovipositional activities like grooming was found highly inthe lethal dose @ 0.0015% and sublethal dose @ 0.00075% with mean duration of 600secand 254.3secsuggested that *T. chilonis* females was tried to clean the body parts in the treated site. The ovipositional activities like searching, examination found on the treated sites of streptomycin sulphate@0.00375% treatment with the duration range of 48.2sec, 174.6sec and the oviposition (226.4sec) was found significantly lower than control.

Effect of botanical pesticide on behavioursof *T. chilonis*

The ovipositional activities of *T.chilonis* females on treated corcerya eggs was restricted in all the treatments of azardiractin (Table 5 and Fig 4). The non-ovipositional activities like grooming was only found in the lethal dose @ 0.000075% and sublethaldose @ 0.000038% with mean duration of 600sec.The circling and grooming activities was found inthesublethaldose @ 0.000087% with mean duration of 564sec and 36sec. The grooming and circling activity was found in all the azardiractin treatments suggested that *T. chilonis* females was tried to avoid the treated sites by cleaning the body and escape.

Table 1. Details of tested chemicals

S.No	Pesticide name	Chemical group and structure	Recommended dose (LD_{50})	Half of recommended dose (LD_{50})	One-fourth of recommended dose (LD_{50})
A)Neonicotinoids and bacterial based insecticides					
1	Imidacloprid 17.8 SL	Neonicotinoid 	@0.0035%, 17.8 g a.i./ ha (0.2 ml/ l of water)	0.00175%, 9 g a.i./ ha (0.1 ml/ l of water)	0.00875%, 4.5 g a.i./ ha (0.05 ml/ l of water)
2	Thiamethoxam 25WG	Neonicotinoid 	@0.005%, 25 g a.i./ ha (0.2 g/ l of water)	@ 0.0025%, 12.5 g a.i./ ha (0.1 g/ l of water)	@ 0.00125%, 6.25g a.i./ ha (0.05 g/ l of water)
3	Spinosad 45 SC	Spinosyn 	@ 0.01%, 99 g a.i./ ha (0.4 ml/ l of water)	@ 0.009%, 49.5 g a.i./ ha (0.2 ml/ l of water)	@ 0.0045%, 24.75 g a.i./ ha (0.1 ml/ l of water)
B)Organophosphate and anthranilic diamide insecticide					
4	Profenophos 50 EC	Organophosphate 	@ 0.1%, 1000 g a.i./ ha (2 ml/ l of water)	@ 0.05%, 500 g a.i./ ha (1 ml/ l of water)	@ 0.025%, 250 g a.i./ ha (0.5 ml/ l of water)

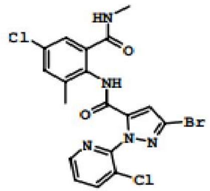
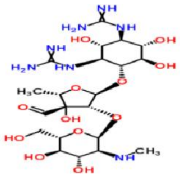
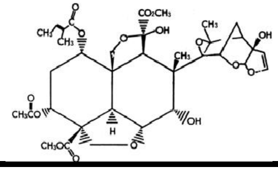
5	Chlorantraniliprole 18.5SC	Anthranilic diamide 	@ 0.006%, 27.75 g a.i./ ha (0.3 ml/ l of water)	@ 0.003%, 13.85 g a.i./ ha (0.15 ml/ l of water)	@ 0.015%, 6.92 g a.i./ ha (0.075 ml/ l of water)
C. Antibiotic					
6	Streptomycin sulphate	Antibiotic 	@0.0015%, 75 g a.i./ ha (0.15 g/ l of water)	@0.00075%, 37.5 g a.i./ ha (0.075 g/ l of water)	@ 0.000375%, 18.75 g a.i./ ha (0.0375 g/ l of water)
D)Botanical insecticide					
7.	Azadirachtin 0.15 EC	Botanical 	@ 0.000075%%, 0.75 g a.i./ ha (5 ml / l of water)	@ 0.000038%, 0.37 g a.i./ ha (2.5 ml / l of water)	@ 0.000087%, 0.18 g a.i./ ha (1.25 ml / l of water)

Table 2. Effect of neonicotinoids and bacterial based insecticides on behaviours of *T. chilonis*

		Mean duration in seconds						
Sr. No	Treatments	Searching	Examination	Oviposition	Resting	Walking	Circling	Grooming
1	Imidacloprid 17.8 SL @ 0.0035%, 17.8 g a.i./ ha (0.2 ml/ l of water)	0.0	0.0	0.0^{c}	0.0	0.0	600.0	0.0
2	Imidacloprid 17.8 SL @ 0.00175%, 9 g a.i./ ha (0.1 ml/ l of water)	0.0	0.0	0.0^{c}	0.0	0.0	600.0	0.0
3	Imidacloprid 17.8 SL @ 0.00875%, 4.5 g a.i./ ha (0.05 ml/ l of water)	0.0	0.0	0.0^{c}	0.0	0.0	600.0	0.0
4	Thiamethoxam 25WG @ 0.005%, 25 g a.i./ ha (0.2 g/ l of water)	0.0	0.0	0.0^{c}	0.0	178.0	422.0	0.0
5	Thiamethoxam 25WG @ 0.0025%, 12.5 g a.i./ ha (0.1 g/ l of water)	0.0	0.0	0.0^{c}	0.0	142.0	458.0	0.0
6	Thiamethoxam 25WG @ 0.00125%, 6.25g a.i./ ha (0.05 g/ l of water)	0.0	0.0	0.0^{c}	0.0	100.0	500.0	0.0
7	Spinosad 45 SC @ 0.019%, 99 g a.i./ ha (0.4 ml/ l of water)	0.0	0.0	0.0^{c}	0.0	31.3	481.0	87.6
8	Spinosad 45 SC @ 0.009%, 49.5 g a.i./ ha (0.2 ml/ l of water)	0.0	0.0	0.0^{c}	0.0	68.0	477.0	55.0
9	Spinosad 45 SC @ 0.0045%, 24.75 g a.i./ ha (0.1 ml/ l of water)	21.6	166.0	208.6^{b}	50.0	103.3	50.3	0.0
10	Water (control)	36.6	103.6	236.0^{a}	69.6	154.0	0.0	0.0
	S. Em			0.79				
	CD at 5%			2.33				
	CV%			2.99				

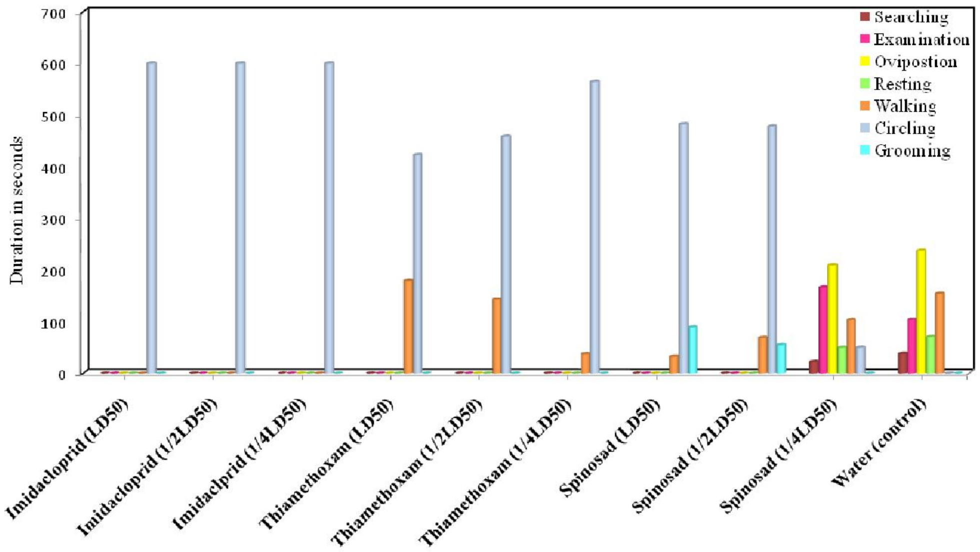


Fig. 1. Effect of neonicotinoids and bacterial based insecticides on behaviours of *T. chilonis*

Table 3. Effect of organophosphate and anthranilic diamide insecticide on behaviours of *T. chilonis*

		Mean duration in seconds						
Sr.No	Treatments	Searching	Examination	Oviposition	Resting	Walking	Circling	Grooming
1	Profenophos 50 EC @ 0.1%, 1000 g a.i./ ha (2 ml/ l of water)	0.0	0.0	0.0[d]	0.0	31.0	488.3	80.6
2	Profenophos 50 EC @ 0.05%, 500 g a.i./ ha (1 ml/ l of water)	0.0	0.0	0.0[d]	0.0	263.6	336.3	0.0
3	Profenophos 50 EC @ 0.025%, 250 g a.i./ ha (0.5 ml/ l of water)	0.0	0.0	0.0[d]	0.0	332.0	268.0	0.0
4	Chlorantraniliprole 18.5SC @ 0.006%, 27.75 g a.i./ ha (0.3 ml/ l of water)	24.0	72.6	211.3[c]	44.6	247.3	0.0	0.0
5	Chlorantraniliprole 18.5 SC @ 0.003%, 13.85 g a.i./ ha (0.15 ml/ l of water)	9.3	96.0	223.3[b]	28.3	243.0	0.0	0.0
6	Chlorantraniliprole 18.5 SC @ 0.015%, 6.92 g a.i./ ha (0.075 ml/ l of water)	11.0	92.6	230.0[ab]	23.6	242.6	0.0	0.0
7	Water (control)	36.6	103.6	236.0[a]	69.6	154.0	0.0	0.0
	S. Em			2.07				
	CD at 5%			6.27				
	CV%			2.74				

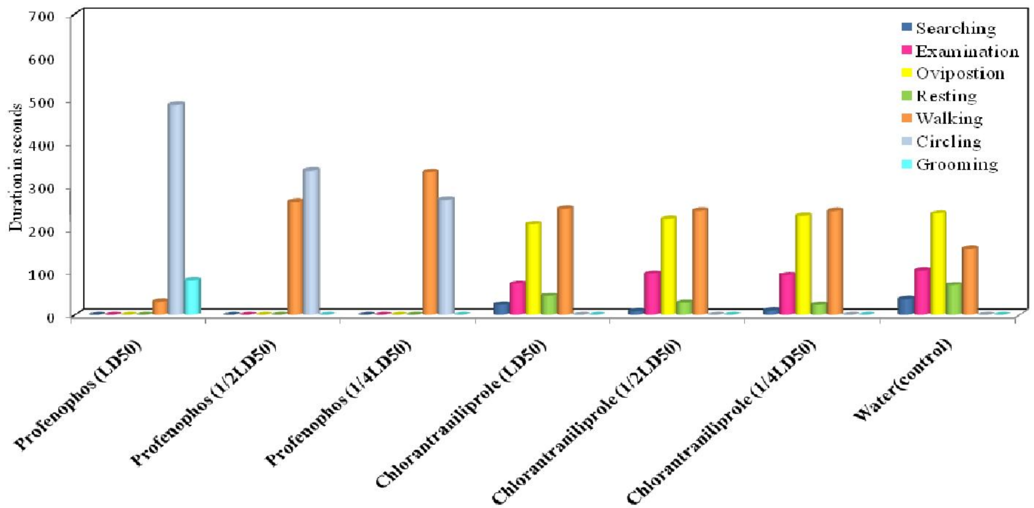


Fig. 2. Effect of organophosphate and anthranilic diamide insecticide on behaviours of *T. chilonis*

Table 4. Effect of antibiotic on behaviours of *T. chilonis*

		Mean duration in seconds						
Sr.No	Treatments	Searching	Examination	Oviposition	Resting	Walking	Grooming	Circling
1	Streptomycinesulphate @0.0015%, 75 g a.i./ ha (0.15 g/ l of water)	0.0	0.0	0.0[c]	0.0	0.0	600.0	0.0
2	Streptomycinesulphate @0.00075%, 37.5 g a.i./ ha (0.075 g/ l of water)	0.0	0.0	0.0[c]	0.0	171.6	254.3	275.8
3	Streptomycinesulphate @ 0.000375%, 18.75 g a.i./ ha (0.0375 g/ l of water)	48.2	174.6	226.4[b]	34.6	124.8	0.0	61.2
4	Water(control)	19.8	179.6	248.8[a]	222.3	150.3	0.0	0.0
	S. Em			1.69				
	CD at 5%			5.08				
	CV%			3.19				

Table 5. Effect of botanical pesticideon behavioursof *T. chilonis*

		Mean duration in seconds						
Sr. No	Treatments	Searching	Examination	Oviposition	Resting	Walking	Grooming	Circling
1	Azadirachtin0.15 EC @ 0.000075%%, 0.75 g a.i./ ha (5 ml / l of water)	0.0	0.0	0.0	0.0	0.0	600.0	0.0
2	Azadirachtin0.15 EC @ 0.000038%, 0.37 g a.i./ ha (2.5 ml / l of water)	0.0	0.0	0.0	0.0	0.0	600.0	0.0
3	Azadirachtin0.15 EC @ 0.000087%, 0.18 g a.i./ ha (1.25 ml / l of water)	0.0	0.0	0.0	0.0	0.0	36.0	564.0
4	Water(control)	19.8	179.6	248.8	222.3	150.3	0.0	0.0

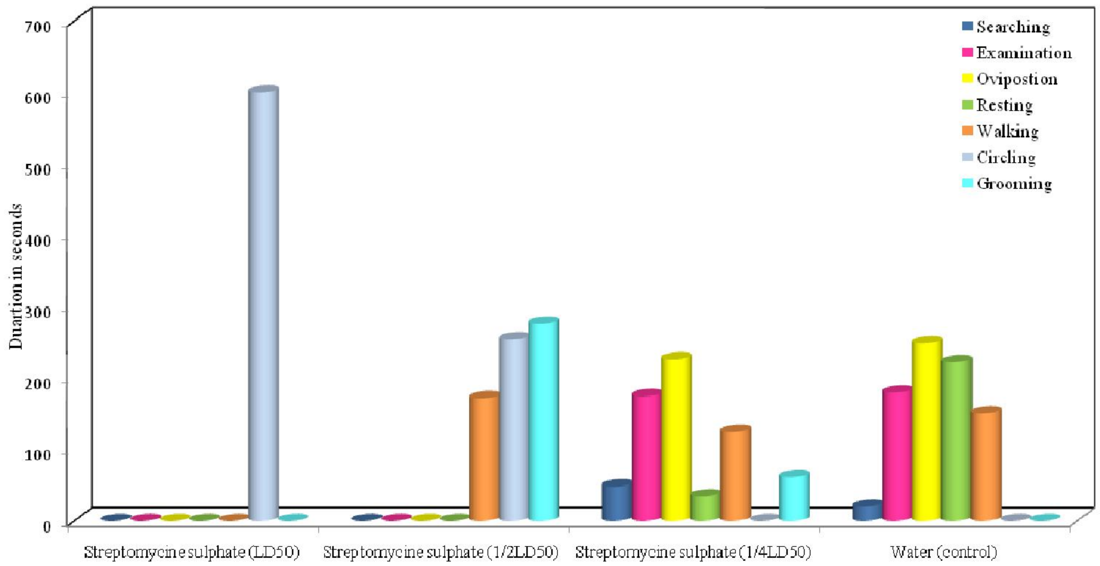


Fig. 3. Effect of antibiotic on behaviors of *T. chilonis*

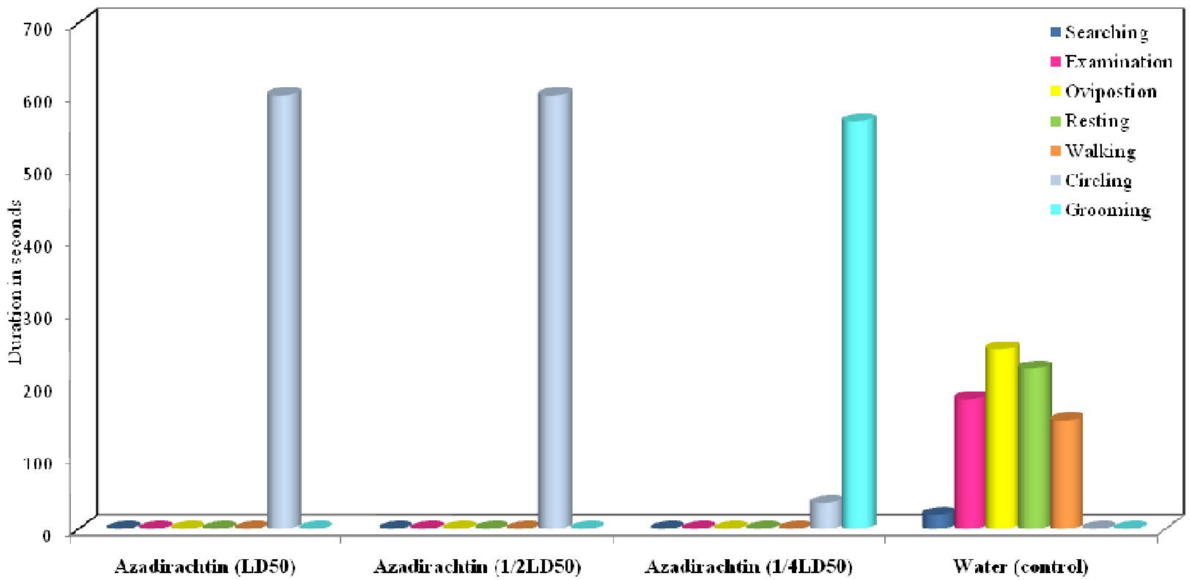


Fig. 4. Effect of botanical pesticide on behaviours of *T. chilonis*

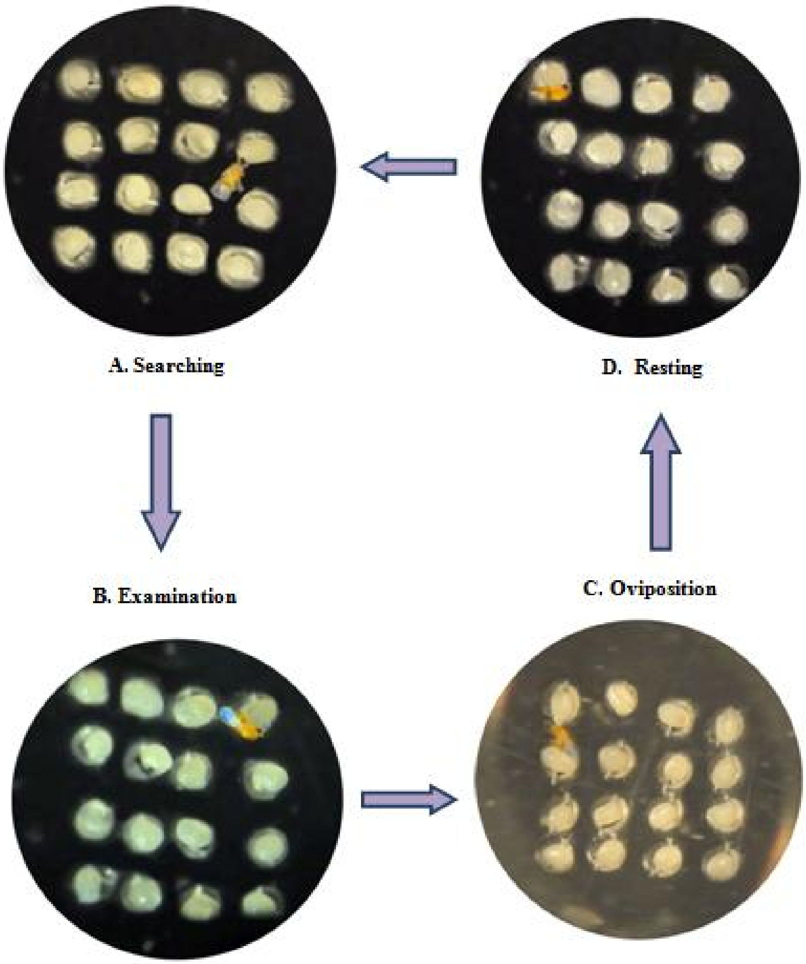


Plate 1. Ovipositional activities of *T. chilonis*femaleson *C. cephalonica* eggs

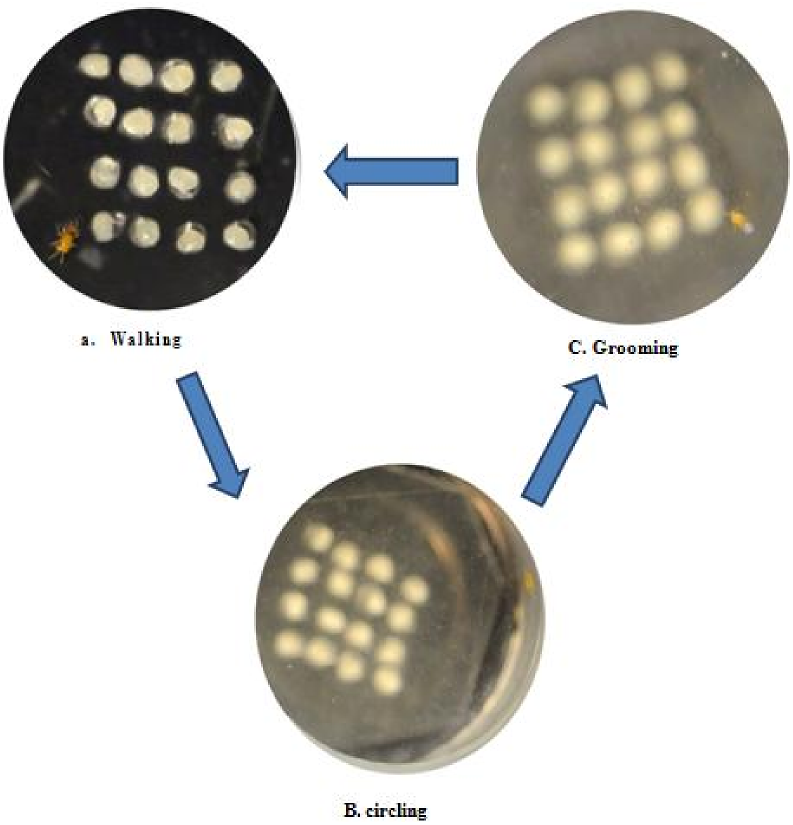


Plate 2. Non- ovipositional activities of *T. chilonis* females on *C. cephalonica eggs*

The different behavioural activities observed in the present investigation of *T. chilonis* on treated sites are found similar to that *T. australicum* by Nurindah *et al.* (1999) and *T. platneri*, T. *pretiosum* by Mills and Kuhlmann (2004) and for *T. evanescens* by S. A. Ahmed (2008). From the present investigation it can be concluded that oviposition preference of *T.chilonis* females on the treated host eggs of chlorantraniliprole and sublethal doses of spinosad was found harmless remaining all chemicals significantly restricted the ovipositional activity as compare to control. Similarly, Satter *et al.* (2011) reported that ovipositional preference of *T. chilonis* females on the host eggs treated with different insecticides showed that reduction in oviposition preference by spinosad 240 % SC, 120.0 mg a.i. L^{-1}>emamectin 1.9% EC, 3.2 mg a.i. L^{-1}>lufenuron 50% EC, 83.3 mg a.i. L^{-1}>indoxacarb 150% EC, 186.7 mg a.i. L^{-1}>flubendiamide 480% SC, 80.0 mg a.i L^{-1} treated eggs.

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