International Conference on
Agriculture and Allied Sciences:
The Productivity, Food Security and Ecology
ISBN-978-93-85822-71-1

Study on Efficacy of Various Synthetic Insecticides against Tea Mosquito Bug (*Helopeltis theivora*) in The Tea Gardens at Terai Region of West Bengal, India

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Abstract—*The efficacy of two commonly used synthetic insecticide viz thiamethoxam and thiacloprid in controlling the infestation of Tea Mosquito Bug (Helopeltis thievora) was studied. Thiacloprid was quite effective in controlling the pest compared to thiamethoxam. The efficacy of thiacloprid was due to the presence of the group thiazolidinylidene. Another important reason of performing good result of thiacloprid compared to thiamexthoxam, is due to the fact that it's relative stability to rain-water and sunlight. It was observed that in untreated control treatment the punches of tea mosquito bug was 48.62% increased but in the thiamethoxam treatment the punches of tea mosquito bug was 25.34% decreased. The infestation was 31.67% decreased in the thiacloprid treatment. The infestation in the thiacloprid treatment was 6.33% less than that of thiamethoxam treatment.*

Keywords*: Tea garden, Tea mosquito bug, insecticides.*

Introduction

Tea is world's most popular beverages and is the economical backbone of various tea producing countries like India. Terai region is an important tea growing area in India. Numerous of large tea estate and small tea growers are present in this region [1]. The tea industries in this region produce mainly CTC tea and also some amount of green tea [2]. Several species of plant sap sucking bugs, belonging to the order Hemiptera, attack tea throughout the world [3,4]. *Helopeltis i*s a bug belonging to the order Hemiptera is a destructive pest that was subsequently discovered in Assam and Darjeeling in the year 1869. It was mentioned that the bug was recorded in north and south banks of Brahmaputra, Cachar, Terai, the Dooars and Darjeeling to cause damage to tea [5]. It decreases the quality of tea and also increases the tea waste production [6]. It was observed that tea mosquito bug attack accrue about 35% of total pest occurrence in Terai region of West Bengal[7].

Adults and nymphs of tea moaquito bug (*Helopeltis thevora*) suck the sap of the young leaves, buds and tender stems by puncturing the tissues[3] . While feeding, the pest injects a toxin that causes necrosis of the area around the feeding spot. The area turns blackish and dries up. In a severe attack bushes look scorched, cease to produce shoots and yield is drastically reduced [4, 5]. The month of attack is from February to November [8]. Adults lay whitish eggs on midrib of the leaves [9]. The eggs are provided with two long filaments, the 'respiratory horns' situated at the margin of operculum [10]. A tea mosquito bug may lay 4-5 eggs/day [11]. The incubation period is 10-13 days. Life cycle is completed in 10-35 days. Nymphal period lasts for 22-23 days. Nymphs are dirty yellow in colour. The adults have a black head, pale yellow and black thorax, yellow and greenish black abdomen [9, 12].

Systematic position of Tea Mosquito Bag:

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Hemiptera

Sub-order: Heteroptera

Family: Miridae

Sub-family: Bryocorinae

Genus: *Helopeltis*

Species: *theivora*

Pest control measures: Tea pests can be controlled in many ways [9].

1) Plant resistance (varietal control): Genetic make-up, tolerance use of mixed varieties

2) **Cultural control:** Destruction of alternate hosts, Barrier Crop, irrigation & fertilizer practice, mulching.

3) **Biological control:** Predators, parasitoids, pathogens, Microbial pesticides e.g. *Bacillus thuringiensis*, Botanical antifeedant and repellants.

4) **Interference method**: Pheromones, Sterile male Technique, Insect Growth Regulators e.g. diflubenzuron

5) **Chemical control**: Chemical pesticides [**Table-1]**

Table 1: TRA recommended and Tea Board Plant Protection code approved pesticides (insecticides) for management of tea mosquito bug (Source: Plant Protection Code; January 2017, Ver. 8.0; Tea Board)[14].

Insecticides	Dilution	
	HV	LV
Deltamethrin 2.8 EC/11 EC	1: 2000	1: 1000
Bifenthrin 8% SC	1: 1600	1: 800
Thiamethoxam 25 WG	1: 4000	1: 2000
Quinalphos 25 EC/ 20AF	1: 400	1: 200
Fenpropathrin 30 EC	1: 1600	1:800
Phosalone 35EC	1: 400	1: 200
Neem Extract (azadirachtin 5% W/W)	1: 1500	1: 750
Clothianidin 50 WDG	1:4500	1:2250
Thiacloprid 21.7%	1:1000	1:500

In these experiment two synthetic pesticides was selected. They are Thiamethoxam 25% WG [**Table-2**] and Thiacloprid 21.7% SC [**Table-2**].

Table 2: The list of Trade name, company and dose of Thiamethoxam 25% WG and Thiacloprid 21.7% SC that available in the market [9].

Pesticide	Trade Name	Company	Dose
Thiamethoxam 25% WG	Champ	Isagro (Asia) Agrochemicals Pvt. Ltd.	0.25 g/litre
	Torpid	Godrej Agrovet Ltd.	0.25 g/litre
	Hilstar	Hindusthan Insecticides Ltd.	0.25 g/litre
	Dxtar	Nagajuna Agrichem Ltd.	0.25 g/litre
	Act 150	SDS Ramcides Crop Science Pvt. Ltd.	0.25 g/litre
	Click	Indofil Industries Ltd.	0.25 g/litre
	Suckgan	Makhteshim-Agan India Pvt. Ltd.	0.25 g/litre
	Anant	Rallis India Pvt. Ltd.	0.25 g/litre
	Slayer	GSP Crop Science Pvt. Ltd.	0.25 g/litre
	Maxima	PI Industries Ltd.	0.25 g/litre
	Actara	Syngenta India Ltd.	0.25 g/litre
	Renova	United Phosphorus Ltd.	0.25 g/litre
	Evident	Biostadt India Ltd.	0.25 g/litre
	Krioxm	Krishi Rasayan	0.25 g/litre
	Caper	Cheminova India Ltd.	0.25 g/litre
Thiacloprid 21.7% SC	Invest	Isagro (Asia) Agrochemicals Pvt. Ltd.	0.75 ml/litre
	Alanto	Bayer Crop Science Ltd.	0.75 ml/litre
	Splendour	Cheminova India Ltd.	0.75 ml/litre

Thiamethoxam 25% WG:

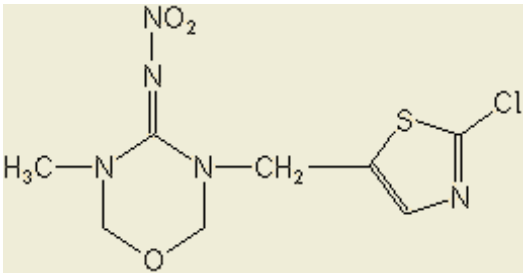
Common name: Thiamethoxam 25% WG

Chemical Name: 3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-*N*-nitro-4*H*-1,3,5-oxadiazin-4-imine

Molecular Formula: $C_8H_{10}ClN_5O_3S$

Activity: Insecticides (nitroguanidine insecticides; thiazole insecticides)

Structural Formula:



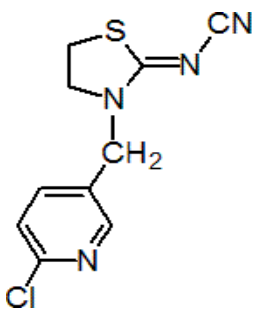
Mode of Action: A broad spectrum systemic insecticide having stomach and contact action [15, 16].

Thiacloprid 21.7% SC:
Common name: Thiacloprid 21.7% SC
Chemical Name: (Z)-3-(6-chloro-3-pyridylmethyl)-1,3-thiazolidin-2-ylidenecyanamide
Molecular Formula: $C_{10}H_9ClN_4S$

Activity: Insecticides (thiazolidinylidene insecticides)

ISBN: 978-93-85822-71-1

Structural formula:



Mode of Action: Thiacloprid is antagonist to the nicotinic acetyl choline receptor in the central nervous system. It disturbs the proper signal transmission system leading to excitation of nerve cell. Consequently a disorder of the nervous system occurs leading finally to the death of the treated insect [17, 18].

Materials and Methods:

Location of the experiment: The experiment was conducted in three different Tea estates.

Location A:

Garden Name: Sukna Tea Estate

Section Number: NB Khal

Latitude: 26°46'2"N

Longitude: 88°23'54"E

Altitude: 478 feet above sea level

Planting Materials (Clone): TV 25 and TV 26

Bush Age: 20 years

Location B:

Garden Name: New Chumta Tea Estate

Section Number: 7B

Latitude: 26°77'12"N

Longitude: 88°36'40"E

Altitude: 518 feet above sea level

Planting Materials (Clone): TV 25 and TV 26

Bush Age: 4 years

Location C:

Garden Name: NBU Tea Plantation Area (Maintained by Matigara Tea Estate)

Section Number: B

Latitude: 26°42'44"N

Longitude: 88°20'48"E

Altitude: 435 feet above sea level

Planting Materials (Clone): TV 25 and TV 26

Bush Age: 13 years

Experimental design and Layout: Three different locations were taken for three field trials. In each the tea fields, 9 plots were taken and each plot contained 12(4×3) bushes. The distance between two hedges was 105 cm and between the two bushes in between the hedge was about 60 cm. Area of the each plot was 9 square meters. Each field trial contained one untreated control (Only normal water spray) and two treatments. There were total 3 treatments and each treatment had 3 replications [12, 13]. The experiments were laid out in Randomised Block Design (RBD).

Treatment 1 (T1): Untreated Control (Only normal water spray)

Treatment 2 (T2): Thiacloprid 21.7% SC

Treatment 3 (T3): Thiamethoxam 25% WG

Preparation of plots: Plot was prepared by Bamboo sticks and each plot is marked with Bamboo sticks in its four corners. Each plot is than marked with paper tag with plot number. Then cello tape was tightly warped around the paper tag to save it from water. Lastly each plot was marked separately with good looking ribbon for proper visibility of the plots.

Collection of pre-treatment Tea Mosquito Bag effected leaves: Hundred leaves were collected in each plot from plucked leaves randomly.

Preparation of pesticides: The pesticides are prepared as recommended dose separately with the help of measuring cylinder, weighing balance and 2 ml syringe. Then in mixed properly and poured into the backpack sprayer machine as per instruction of the pesticides. Then it sprays into the plots according to the RBD design. After each pesticide spray the backpack sprayer machine was cleaned and afterwards put another.

Doses of the pesticides:

Thiacloprid 21.7% SC @ 0.75ml/litre

Thiamethoxam 25% WG @ 0.25g/litre

Spraying: After that the pesticide was sprayed by ASPEE backpack sprayer machine as per RBD design of treatments.

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Collection of post-treatment Tea Mosquito Bag effected leaves: After 7 days of treatment, post treatment observation was taken. In post treatment observation hundred leaves were collected in each plot from plucked leaves randomly.

Results and Calculation:

Before spray (pre-treatment) infested leaves number and total punch marks in each plot were counted from hundred numbers of leaves which were collected from each plot [**Table 3-11**]. After treating with pesticides (post-treatment), same procedure was followed [**Table 3-11**]. Then the mean value of infested leaves number and total punch marks in each plot of pre-treatment and post-treatment were compared[9] [**Table 12 & Fig 1]**. After that the increasing or decreasing percentage of punch/leaf between pre-treatment and post-treatment in case of different treatment is measured [**Table 13**].

Table 3: Location A

OBSERVATION	TREATMENT 1 (Only normal water spray)								
	REPLICATION 1		REPLICATION 2		REPLICATION 3		Total infested leaves out of 300 leaves	Total punch marks out of 300 leaves	Punch/ leaf
	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100			
PRE-TREATMENT	5	103	21	523	13	134	39	760	2.53
POST-TREATMENT	23	362	10	171	22	754	55	1287	4.29

Table 4: Location A

OBSERVATION	TREATMENT 2 (Thiocloprid 21.7% SC)								
	REPLICATION 1		REPLICATION 2		REPLICATION 3		Total infested leaves out of 300 leaves	Total punch marks out of 300 leaves	Punch/ leaf
	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100			
PRE-TREATMENT	12	271	8	197	17	140	37	608	2.02
POST-TREATMENT	15	274	14	114	19	88	48	476	1.5

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Table 5: Location A

OBSERVATION	TREATMENT 3 (Thiamethoxam 25% WG)								
	REPLICATION 1		REPLICATION 2		REPLICATION 3		Total infested leaves out of 300 leaves	Total punch marks out of 300 leaves	Punch/ leaf
	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100			
PRE-TREATMENT	18	219	23	277	20	186	61	682	2.27
POST-TREATMENT	13	89	7	105	11	316	31	510	1.64

Table 6: Location B

OBSERVATION	TREATMENT 1 (Only normal water spray)								
	REPLICATION 1		REPLICATION 2		REPLICATION 3		Total infested leaves out of 300 leaves	Total punch marks out of 300 leaves	Punch/leaf
	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100			
PRE-TREATMENT	9	180	21	235	30	189	60	604	2.01
POST-TREATMENT	30	287	38	344	47	255	115	886	2.95

Table 7: Location B

OBSERVATION	TREATMENT 2 (Thiocloprid 21.7% SC)								
	REPLICATION 1		REPLICATION 2		REPLICATION 3		Total infested leaves out of 300 leaves	Total punch marks out of 300 leaves	Punch/leaf
	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100			
PRE-TREATMENT	19	356	25	261	21	626	65	1243	4.14
POST-TREATMENT	15	202	21	162	16	431	52	795	2.65

ISBN: 978-93-85822-71-1

Table 8: Location B

OBSERVATION	TREATMENT 3 (Thiamethoxam 25% WG)								
	REPLICATION 1		REPLICATION 2		REPLICATION 3		Total infested leaves out of 300 leaves	Total punch marks out of 300 leaves	Punch/ leaf
	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100			
PRE-TREATMENT	25	103	23	88	16	255	64	446	1.48
POST-TREATMENT	12	95	9	49	15	158	36	302	1.01

Table 9: Location C

OBSERVATION	TREATMENT 1 (Only normal water spray)								
	REPLICATION 1		REPLICATION 2		REPLICATION 3		Total infested leaves out of 300 leaves	Total punch marks out of 300 leaves	Punch /leaf
	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100			
PRE-TREATMENT	9	180	21	235	30	189	60	604	2.01
POST-TREATMENT	24	289	19	224	10	210	53	743	2.48

ISBN: 978-93-85822-71-1

Table 10: Location C

OBSERVATION	TREATMENT 2 (Thiocloprid 21.7% SC)								
	REPLICATION 1		REPLICATION 2		REPLICATION 3		Total infested leaves out of 300 leaves	Total punch marks out of 300 leaves	Punch/ leaf
	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100			
PRE-TREATMENT	25	484	17	498	19	411	61	1393	4.64
POST-TREATMENT	18	185	32	506	22	287	72	978	3.26

Table 11: Location C

OBSERVATION	TREATMENT 3 (Thiamethoxam 25% WG)								
	REPLICATION 1		REPLICATION 2		REPLICATION 3		Total infested leaves out of 300 leaves	Total punch marks out of 300 leaves	Punch/ leaf
	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100	Number of infested leaves out of 100 leaves	Total punch marks out of 100			
PRE-TREATMENT	30	152	22	299	23	380	75	831	2.77
POST-TREATMENT	20	286	13	172	15	204	48	662	2.21

Table 12: Mean value puncture per leaf of pre-treatment and post-treatment observations in all locations

TREATMENTS	PRE-TREATMENT(PUNCH/LEAF)				POST-TREATMENT(PUNCH/LEAF)			
	LOCATION A	LOCATION B	LOCATION C	MEAN	LOCATION A	LOCATION B	LOCATION C	MEAN
TREATMENT 1	2.53	2.01	2.01	2.18	4.29	2.95	2.48	3.24
TREATMENT 2	2.02	4.14	4.64	3.6	1.5	2.65	3.26	2.46
TREATMENT 3	2.27	1.48	2.77	2.17	1.64	1.01	2.21	1.62

ISBN: 978-93-85822-71-1

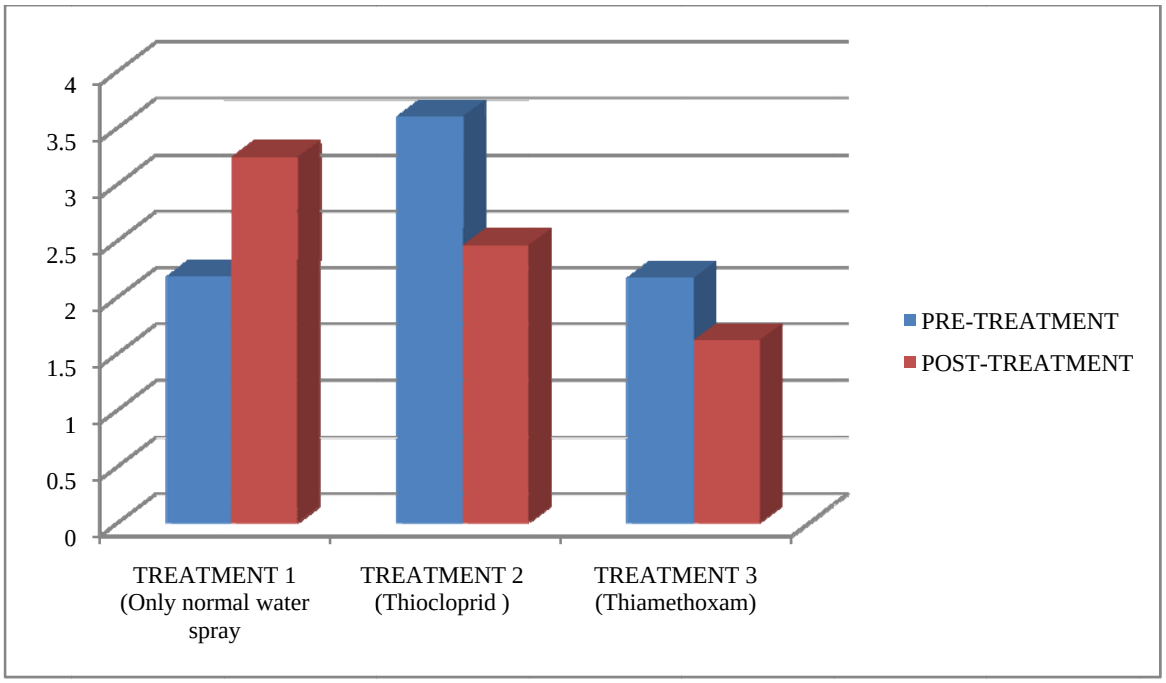

Fig. 1: Comparison between mean value puncture per leaf of pre-treatment and post-treatment observations in all locations

Table 13: Increasing or decreasing percentage of punch/leaf between pre-treatment and post-treatment

TREATMENT	PRE-TREATMENT	POST-TREATMENT	(PRE-TREATMENT) - (POST-TREATMENT)	INCREASING OR DECREASING PERCENTAGE OF PUNCH/LEAF
T1	2.18	3.24	-1.06	-48.62%
T2	3.6	2.46	1.14	31.67%
T3	2.17	1.62	0.55	25.34%

Statistical analysis:

(Using Minitab)

Table 14: Two-way ANOVA: PPL versus Treatments, Altitude

Analysis of Variance for PPL

Source	DF	SS	MS	F	P
Treatment	5	8.179	1.636	2.07	0.153
Altitude	2	1.085	0.543	0.69	0.525
Error	10	7.893	0.789		
Total	17	17.157			

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Table 15: Two-way ANOVA: PPL versus Treatments, Bush age

Analysis of Variance for PPL

Source	DF	SS	MS	F	P
Treatment	5	8.179	1.636	2.07	0.153
Bush age	2	1.085	0.543	0.69	0.525
Error	10	7.893	0.789		
Total	17	17.157			

PPL=Punch per leaf

Discussion:

The information regarding the study of efficacy of synthetic insecticides in Terai region of West Bengal, it is determined that, among the two insecticides (Thiamethoxam 25 % WG and Thiocloprid 21.7% SC), thiocloprid shows efficient result in comparison to thiamethoxam in all three locations. The efficacy of thiacloprid was due to the presence of the group thiazolidinylidene. Another important reason of performing good result of thiacloprid compared to thiamexthoxam, is due to the fact that it's relative stability to rain-water and sunlight. In this experiment altitude and bush age variation was also used but in every location the result is apparently same. The minor difference in the efficacy may be due to the agro climatic changes, temperature, altitude and bush age variation. Statistical analysis of the experiment shows that P value of treatments in two way ANNOVA is less than 0.5 that's mean there is no significant variation between the treatments in the experiment **[Table 14-15]**. And in case of altitude and bush age the P value of two way ANNOVA is more than 0.5 it indicates that there is significant variation is present in altitude and bush age **[Table 14-15]** compare with punch per leaf.

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ISBN: 978-93-85822-71-1