

# Effect of Bio-pesticides on mortality of Greater wax moth *Galleria mellonella* L.

## ABSTRACT

*Galleria mellonella* larvae feed on wax, pollen, honey and damage the combs with in active bee colonies and storage condition. *Galleria mellonella* larvae can bore tunnel and feed around the midrib base of the wax comb. Larvae produce silk fibers that can trap bee brood cells. Comb is completely covered with webbing and extracted matter of the larvae condition described as “Galleriasis”. The study was carried out at Apiculture Lab of RVSKVV-ZARS-Krishi Vigyan Kendra, Morena (M.P.) during 2019-20. Different three concentration of bio-pesticides viz., *Bacillus thuringiensis* *Kurstaki* (1, 1.5 and 2%), custard apple seed extract (2, 4 and 6%) and Neem Oil (1, 2 and 3%) were used against the *Galleria mellonella* to assess the effect of larval mortality at 24, 48, 72 and 96 hours after treatment. There was no significant effect showed in all the treatments after 24 hours. The maximum mortality of *Galleria mellonella* larvae was recorded in *Bacillus thuringiensis* *Kurstaki* 2.0 percent concentration (46.67, 87.08 and 96.67%) after 48, 72 and 96 hours respectively and it was at par with custard apple seed extract 6.0 percent concentration (45.83, 85.0 and 93.75%). Neem oil 3.0 percent concentration expressed 38.33, 75.42 and 87.50 percent larval mortality after 48, 72 and 96 hours respectively. Whereas minimum mortality was noticed in Neem oil 1.0 percent at 48 hours (22.08 %), at 72 hours (37.08%) and at 96 hours (56.25%) among the treatments. The higher concentration of all the three bio-pesticides was proved effectiveness against *Galleria mellonella* during investigation.

**Keywords:** *Bacillus thuringiensis* *Kurstaki*, custard apple seed extract, *Galleria mellonella*, neem oil, mortality.

## INTRODUCTION

Honey bee rearing or scientifically we all so called beekeeping and apiculture. Beekeeping in India dates back to pre-historic era when indigenous methods farthest from scientific beekeeping and approach when in practice. Apiculture occupies an important position in the agriculture sector; it contributes significantly to the gross domestic product (GDP) of the Indian economy as well as the rural economy. In addition to the direct and

indirect benefits of beekeeping to humans, there are direct benefit is honey, bee. Bee venom, royal jelly, pollen, propolis, queen bee and medicines raw materials and the indirect benefits is improving agricultural productivity due to bee pollination, raising awareness among the people for forest conservation, improving family nutrition and employment generation. Bee keeping industry is currently facing many challenges around the world. Among these, a major obstacle to beekeeping development programme is the increase in the number of enemies and diseases, Bees are attacked by many disease and pests, which cause weakening of the colonies and eventually produce low grade honey. Bees are also attacked by many insects such as the greater wax moth (*Galleria mellonella* L.) and the small wax moth, (*Achroia grisella* F.). Two species of wax moth, the greater wax moth and small wax moth are occurs naturally in various region of the world. Wax moth is the most common insect pest. Wax moth caterpillars feed on wax, pollen and honey and damage the combs within active bee colonies and storage conditions, resulting in massive losses worldwide (Williams, 1997; Milam, 1970). Greater wax moth larvae can bore tunnel and feed around the midrib base of the wax comb. Larvae produce silk fibers that can trap bee brood cells. Comb is completely covered with webbing and excreted matter of the larvae condition described as "*Galleriasis*". In the severe infestation of the wax moth the bee colonies are weak, in strong colonies the number of bees is decreased rapidly and the colonies were completely destroyed by Greater wax moth (Swamy, 2005). Of the two species of wax moth, the Greater wax moth leads to greater losses compared to Lesser wax moth (Kapil and Sihag, 1983). For the management of greater wax moth best way is use of natural products it's more sustainable option because of their lower toxicity to the environment and the bee colony.

## MATERIALS AND METHODS

The study was conducted in the Apiculture Lab of RVSKVV- ZARS- Krishi Vigyan Kendra Morena (M.P.) during 2019-20. The treatments *Bacillus thuringiensis* var. *kurstaki*(1,

1.5 and 2 %), custard apple seed extract (2, 4 and 6 %) and neem oil (1, 2 and 3%) and untreated use as a check.

### **Custard apple seed extract**

For the preparation of custard apple seed extract the custard apple seeds was collected from fully ripened fruits and washed with water and shade dried, the dried seeds were crushed by using hammer mill and the grinded material was screened through fine mesh sieve. For preparation of 2 percent aqueous custard apple seed extract, the 20 g of seed powder was mixed with 1-liter distilled water and this mixture was soaked overnight. It was then screen through muslin cloth and the volume of the passing liquid (extract) was maintained to 980 milliliters by adding distilled water. Similarly, 4 & 6 per cent aqueous seed extracts were also prepared and the freshly prepared extracts were used for laboratory evaluation.

### ***Bacillus thuringiensis* var. *kurstaki***

For preparation of desired concentrations, the technical material of *Bacillus thuringiensis* var. *kurstaki* 5% WS was collected from the market. Technical material of 1.0, 1.5 and 2.0 ml was mixed with 100, 150 and 200 ml of distilled water for preparation of 1.0, 1.5 and 2.0 percent solution respectively.

### **Preparation of Neem oil solution**

The technical grade material of Neem oil 1000 ppm was collected from the market. For preparation of desired 1.0, 2.0 and 3.0 percent solution, 1.0, 2.0 and 3.0 ml of neem oil was mixed with 100, 200 and 300ml of distilled water respectively.

The various concentrations of bio pesticides were prepared in water. The *Galleria Mellonella* larvae and pupae was collected from stored old combs of *Apis mellifera* in the apiary of RVSKVV-Krishi Vigyan Kendra, Morena for maintain the fresh culture in the

laboratory. *Galleria Mellonella* male and female was reared in the laboratory and fresh culture of various instar larvae was used in the experimentation. Cut piece of old combs of *A. mellifera* was dipped in this different type of solutions of respective concentrations for two minutes and shake gently to remove the excess of suspension from the piece comb, treated comb piece was be shade dried. Individual treated comb piece was put in separate jars. The ten numbers of second instar larvae of *G. mellonella* were released separately into jars containing the treated combs and record the mean mortality of the larva was observed 24, 48, 72 and 96 hours of the various larval stages. The experiment was conducted in completely randomized design (CRD) with ten treatments and four replications. Making the ANOVA after suitable transformations and separated by least significant difference (LSD) at  $p=0.05$  level.

## RESULTS AND DISCUSSION

The effect of different concentration of bio-pesticides on the larval mortality of *Galleria mellonella* at 24, 48, 72 and 96 hours were showed in table 1, 2 and 3.

### Mortality of second instar of *Galleria mellonella*

The findings of mean mortality of second instar *Galleria mellonella* revealed that *Bacillus thuringiensis* Kurstaki 2.0 % recorded maximum mortality (63.75%) and it was similar effective with custard apple seed extract 6% (63.12%) and Neem Oil 3% (59.37%) followed by BtK 1.5% (48.75%) and minimum mean mortality was recorded in neem oil 1.0% (36.25%) (Table3). There was no significant effect showed by all the treatment before 48 hours in second instar larval mortality of *Galleria mellonella*. *Bacillus thuringiensis* Kurstaki 2.0 % showed significant effect on second instar mortality at 72 hours (95.0%) and 96 hours (97.50%) but at 48 hours custard apple seed extract 6.0% was found most effective (60.0%) among the treatments (Table 1). Neem oil 1.0% was found least effective at 48 hours (35.0%), 72 hours (55.0%) and 96 hours (55.0%) on second instar mortality.

### **Mortality of third instar of *Galleria mellonella*:**

Data of mean mortality of third instar *Galleria mellonella* showed that *Bacillus thuringiensis* Kurstaki 2.0 % (61.88%) and custard apple seed extract 6.0% (61.88%) was found most effective on third instar mortality and it was at par with Neem Oil 3% (56.25%) followed by that *Bacillus thuringiensis* Kurstaki 1.5% (45.0%) (Table 3). There was no significant effect found in all the treatment before 48 hours in second instar larval mortality of *Galleria mellonella*. *Bacillus thuringiensis* Kurstaki 2.0% and custard apple seed extract 6.0% was found most effective at 48 hours (55.0 and 55.0%), 72 hours (90.0 and 92.5%) and 96 hours (97.5 and 95.0%) mortality respectively and it was at par with neem oil 3.0% at 48 hours (45.0%), 72 hours (85.0%) and 96 hours (92.5%). *Bacillus thuringiensis* Kurstaki 1.0% was least effective at 48 hours (25.0%), 72 hours (52.50%) and 96 hours (55.0%) (Table1).

### **Mortality of fourth instar of *Galleria mellonella*:**

The observations of mean mortality of fourth instar larvae of *Galleria mellonella* revealed that *Bacillus thuringiensis* Kurstaki 2.0% (61.25%) was found most effective and it was similar with custard apple seed extract 6.0% (56.88%) and Neem Oil 3% (55.63%) followed by custard apple seed extract 4.0% (46.25%). Neem oil 1.0% (32.5%) was recorded least effective among the bio-pesticides (Table 3). After 48 hours treatments showed significant effect on fourth instar larval mortality. *Bacillus thuringiensis* Kurstaki 2.0% was found significantly effective at 48 hours (57.5%), 72 hours (87.5%) and 96 hours (95.0%) and it was at par with custard apple seed extract 6.0% (50.0, 80.0 and 92.5%) and Neem Oil 3.0% (50.0, 77.5 and 90%) at 48, 72 and 96 hours after treatment respectively (Table 1). *Bacillus thuringiensis* Kurstaki 1.0% was recorded least effective on fourth instar mortality at 48 hours (27.5%), 72 hours (40.0%) and 96 hours (60.0%) among the treatments.

### **Mortality of fifth instar of *Galleria mellonella*:**

The data of mean mortality of fifth instar larvae of *Galleria mellonella* revealed that *Bacillus thuringiensis* Kurstaki 2.0% (56.25%) was showed significant effect on fourth instar mortality and it was similar effective with custard apple seed extract 6.0% (55%) and Neem Oil 3.0% (52.5%) followed by that *Bacillus thuringiensis* Kurstaki 1.5% (37.50%) (Table 3). The neem oil 1.0% (28.13%) was found least effective among the treatments. There was no

significant effect recorded in the treatments before 48 hours in fifth instar larval mortality. *Bacillus thuringiensis* Kurstaki 2.0% (45.0 and 97.5%) was found most effective on fifth instar larval mortality of *Galleria mellonella* at 48 hours and 96 hours and it was at par with custard apple seed extract 6.0% (42.5% and 92.5%) and Neem Oil 3.0% (35.0% and 90.0%) at 48 and 96 hours respectively. But at 72 hours maximum mortality was recorded in Neem oil 3.0% (82.5%) and it was similar with custard apple seed extract 6.0% (80.0%) and *Bacillus thuringiensis* Kurstaki 2.0% (77.5%) (Table1).

#### **Mortality of sixth instar of *Galleria mellonella*:**

Data of mean mortality of sixth instar larvae revealed that *Bacillus thuringiensis* Kurstaki 2.0% (53.13%) and custard apple seed extract 6.0% (53.13%) was found similar effective followed by Neem Oil 3.0% (41.25%). Neem oil 1.0% (18.75%) recorded least effective on sixth instar mortality among the treatments (Table 3). Custard apple seed extract 6.0% (35.0%) was found most effective at 48 hours and it was similar with *Bacillus thuringiensis* Kurstaki 2.0% (30.0%) and neem oil 3.0% (25.0%) followed by *Bacillus thuringiensis* Kurstaki 1.5% (22.5%) (Table 2). *Bacillus thuringiensis* Kurstaki 2.0% was found effective on larval mortality of sixth instar at 72 hours (85.0%) and 96 hours (95.0%) and it was also similar effective with Custard apple seed extract 6.0% (80.0% and 92.5%) at 72 hours and 96 hours followed by *Bacillus thuringiensis* Kurstaki 1.5% (60.0%) at 72 hours and neem oil 3.0% (80.0%) at 96 hours.

#### **Mortality of Seventh instar of *Galleria mellonella*:**

The mean data of seventh instar larval mortality showed that *Bacillus thuringiensis* Kurstaki 2.0% (56.25%) was found most effective and it was at par with custard apple seed extract 6.0% (55.0%) followed by Neem Oil 3.0% (52.50%) (Table3). There was no significant effect recorded in the treatments before 48 hours. *Bacillus thuringiensis* Kurstaki 2.0% was recorded significantly effective on seventh instar larval mortality at 48 hours (37.5%), at 72 hours (87.5%) and at 96 hours (97.5%) (Table2). *Bacillus thuringiensis* Kurstaki 2.0% was showed similar results on seventh instar mortality with custard apple seed extract 6.0% (32.5%), custard apple seed extract 4.0% (27.5%), ). *Bacillus thuringiensis* Kurstaki 1.5% (25.0%) and neem oil 3.0% (25.0%) at 48 hours and also with custard apple seed extract 6.0% at 72 hours (85.0%) and 96 hours (95.0%). Neem oil 1.0% was found least effective at 48 hours and 72 hours among the treatments.

### Overall mortality of *Galleria mellonella*:

The data of overall mortality of different instar of *Galleria mellonella* revealed that before 48 hours there was no significant effect found in all the treatments (Table2). The maximum overall mortality was recorded in *Bacillus thuringiensis* Kurstaki 2.0% at 48 hours (46.67%), at 72 hours (87.08%) and at 96 hours (96.67%), it was similar effective with custard apple seed extract 6.0% (45.83%, 85.0% and 93.75%) at 48, 72 and 96 hours respectively. Neem oil 3.0% was also proved effectiveness against overall mortality of *Galleria mellonella* larvae, it was 38.33 % mortality at 48 hours, 75.42% at 72 hours and 87.50 % at 96 hours. Neem oil 1.0% was found least effective on overall mortality among the treatments at 48, 72 and 96 hours.

The present findings supports from the findings of Viraktamath *et al.*, (2005), Gowda and Roopa (2001) and Burges(1978) who reported that small larvae of greater wax moth were more susceptible to *Bt* than the older larvae. Verma (1995), MC Killup and Brown (1991), Cantwell and Shieh, (1981), Izhar-ul-Haq *et al.*, (2008). Swamy *et al.*, (2003) and Kapil and Sihag (1983) also studied the effect of *Bt* as a bio-control agent against *G. mellonella* and effective to controlling *G. mellonella* without any adverse effect on the honey bees. Goodwin (1985) and Molin *et al.* (1987) also found adequate control of *G. mellonella* by using B 401 (a formulation of *Bt* spores and crystals) for a longer period. Verma (1995) also witnessed a similar efficacy of Dipel on *G. mellonella* larvae in *Apis cerana indica* colonies. The data recorded on effect of different concentration of bio-pesticides on the overall mortality of greater wax moth larvae after 48, 72 and 96 hours of treatments application showed significant effect on overall larval mortality, maximum mortality was recorded in *B. thuringiensis* var. *kurstaki* @ 2 % con. and it was at par with custard apple seed extract @ 6 % con. followed by neem oil @ 3 % con. Viraktamath *et al.* (2005), Kuusik *et al.* (1993) and Swamy *et al.*, (2003) are support the above findings. The different concentrations of the custard apple seed extract was used for management of other lepidopteron pest at field and laboratory levels but there is no work and review found on greater wax moth management.

Custard apple seed extract was showing significant effect on the all-larval stage of greater wax moth management at laboratory level in present studies.

## CONCLUSION

Different concentration of bio-pesticides incorporated in the study revealed that the treatment *Bacillus thuringiensis* Kurstaki 2.0% % and custard apple seed extract 6.0% results in the superior to control the infestation of *Galleria mellonella* as compared to other treatments. Treatments *Bacillus thuringiensis* Kurstaki 2.0% and custard apple seed extract 6.0% concentration were proved effectiveness on overall larval mortality at 24, 48, 72 and 96 hours. Both treatments were found similar effective on different instar larval mortality of *Galleria mellonella* during the investigation. *Bacillus thuringiensis* Kurstaki 2.0% and custard apple seed extract 6.0% concentration can be used for control of *Galleria mellonella* commercial beekeeping.

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**Table-1: Effect of bio-pesticides on mortality of Greater wax moth (II, III, IV and V instar larval stage)**

Treatment	Percent mortality of different larval instar of <i>Galleria mellonella</i>															
	II Instar				III Instar				IV Instar				V Instar			
	24 hr.	48 hr.	72 hr.	96 hr.	24 hr.	48 hr.	72 hr.	96 hr.	24 hr.	48 hr.	72 hr.	96 hr.	24 hr.	48 hr.	72 hr.	96 hr.
T1- <i>Bacillus thuringiensis</i> var. <i>kurstaki</i> @ 1.0 %	0.00 (0.00)*	27.50 (31.63)	50.00 (45.00)	72.50 (58.37)	5.00 (12.92)	25.00 (30.00)	52.50 (46.43)	55.00 (47.87)	0.00 (0.00)	27.5 (31.63)	40.00 (39.23)	60.00 (50.77)	0.00 (0.00)	25.00 (30.00)	37.50 (37.76)	55.00 (47.87)
T2- <i>Bacillus thuringiensis</i> var. <i>kurstaki</i> @ 1.5 %	2.50 (9.10)	45.00 (42.13)	60.00 (50.77)	87.50 (69.30)	2.50 (9.10)	40.00 (39.23)	50.00 (45.00)	87.50 (69.30)	2.50 (9.10)	42.50 (40.69)	55.00 (47.87)	75.00 (60.00)	2.50 (9.10)	37.50 (37.76)	52.50 (46.43)	80.00 (63.44)
T3- <i>Bacillus thuringiensis</i> var. <i>kurstaki</i> @ 2.0 %	7.50 (15.89)	55.00 (47.87)	95.00 (77.08)	97.50 (80.9)	5.00 (12.92)	55.00 (47.87)	90.00 (71.57)	97.50 (80.90)	5.00 (12.92)	57.50 (49.31)	87.50 (69.3)	95.00 (77.08)	5.00 (12.92)	45.00 (42.13)	77.50 (61.68)	97.50 (80.9)
T4- Custard apple seed extract @ 2.0 %	0.00 (0.00)	37.50 (37.76)	57.50 (49.31)	72.50 (58.37)	0.00 (0.00)	42.50 (40.69)	57.50 (49.31)	65.00 (53.73)	0.00 (0.00)	35.00 (36.27)	52.50 (46.43)	75.00 (60.00)	0.0 (0.00)	25.00 (30.00)	42.50 (40.69)	67.50 (55.24)
T5- Custard apple seed extract @ 4.0 %	0.00 (0.00)	50.00 (45.00)	62.50 (52.24)	77.50 (61.68)	0.00 (0.00)	45.00 (42.13)	57.50 (49.31)	77.50 (61.68)	0.00 (0.00)	37.50 (37.76)	65.00 (53.73)	82.50 (65.27)	2.50 (9.10)	30.00 (33.21)	47.50 (43.57)	75.00 (60.00)
T6- Custard apple seed extract @ 6.0 %	5.00 (12.92)	60.00 (50.77)	92.50 (74.11)	95.00 (77.08)	5.00 (12.92)	55.00 (47.87)	92.50 (74.11)	95.00 (77.08)	5.00 (12.92)	50.00 (45.00)	80.00 (63.44)	92.50 (74.11)	5.00 (12.92)	42.50 (40.69)	80.00 (63.44)	92.50 (74.11)
T7- Neem oil @ 1.0 %	0.00 (0.00)	35.00 (36.27)	55.00 (47.87)	55.00 (47.87)	0.00 (0.00)	27.50 (31.63)	45.00 (42.13)	70.00 (56.79)	0.00 (0.00)	25.00 (30.00)	42.50 (40.69)	62.50 (52.24)	0.00 (0.00)	27.50 (31.63)	32.50 (34.76)	52.50 (46.43)
T8- Neem oil @ 1.5 %	0.00 (0.00)	42.50 (40.69)	55.00 (47.87)	67.50 (55.24)	2.50 (9.10)	40.00 (39.23)	57.50 (49.31)	75.00 (60.00)	2.50 (9.10)	30.00 (33.21)	55.00 (47.87)	75.00 (60.00)	2.50 (9.10)	25.00 (30.0)	50.00 (45.00)	72.50 (58.37)
T9- Neem oil @ 2.0 %	2.50 (9.10)	50.00 (45.00)	90.00 (71.57)	95.00 (77.08)	2.50 (9.10)	45.00 (42.13)	85.00 (67.21)	92.50 (74.11)	5.00 (12.92)	50.00 (45.00)	77.50 (61.68)	90.00 (71.57)	2.50 (9.10)	35.00 (36.27)	82.50 (65.27)	90.00 (71.57)
T10- Untreated check	2.50 (9.10)	5.00 (12.92)	5.00 (12.92)	7.50 (15.89)	2.50 (9.10)	5.00 (12.92)	5.00 (12.92)	5.00 (12.92)	0.00 (0.00)	2.50 (9.10)	5.00 (12.92)	5.00 (12.92)	0.00 (0.00)	2.50 (9.10)	2.50 (9.10)	2.50 (9.10)
<b>SEm±</b>	3.36	3.01	4.41	4.27	4.31	2.78	4.29	4.36	3.56	2.81	3.45	4.03	3.76	2.95	3.2	4.06
<b>CD</b>	<b>NS</b>	8.68	12.73	12.33	<b>NS</b>	8.04	12.41	12.61	<b>NS</b>	8.13	9.96	11.65	<b>NS</b>	8.54	9.24	11.75

(\*) Figures in parenthesis are arcsine transformed value, NS=Non-Significant

**Table-2: Effect of bio-pesticides on mortality of Greater wax moth (VI and VII instar larval stage)**

Treatment	Percent mortality of different larval instar of <i>Galleria mellonella</i>								Overall Per cent Mortality			
	VI Instar				VII Instar							
	24 hr.	48 hr.	72 hr.	96 hr.	24 hr.	48 hr.	72 hr.	96 hr.	24 hr.	48 hr.	72 hr.	96 hr.
T1- Bacillus thuringiensis var. kurstaki @ 1.0 %	0.00 (0.00)*	12.50 (20.7)	40.00 (39.23)	55.00 (47.87)	0.00 (0.00)	17.50 (24.73)	40.00 (39.23)	60.00 (50.77)	0.83 (5.24)	22.50 (28.32)	43.33 (41.17)	59.58 (50.53)
T2- Bacillus thuringiensis var. kurstaki @ 1.5 %	2.50 (9.10)	22.50 (28.32)	60.00 (50.77)	77.50 (61.68)	0.00 (0.00)	25.00 (30)	62.50 (52.24)	75.00 (60)	2.08 (8.3)	35.42 (36.52)	56.67 (48.83)	80.42 (63.73)
T3- Bacillus thuringiensis var. kurstaki @ 2.0 %	2.50 (9.10)	30.00 (33.21)	85.00 (67.21)	95.00 (77.08)	0.00 (0.00)	37.50 (37.76)	87.50 (69.3)	97.50 (80.9)	4.17 (11.78)	46.67 (43.09)	87.08 (68.94)	96.67 (79.48)
T4- Custard apple seed extract @ 2.0 %	0.00 (0.00)	15.00 (22.79)	27.50 (31.63)	35.00 (36.27)	0.00 (0.00)	12.50 (20.7)	30.00 (33.21)	40.00 (39.23)	0.00 (0)	27.92 (31.89)	44.58 (41.89)	59.17 (50.28)
T5- Custard apple seed extract @ 4.0 %	0.00 (0.00)	22.50 (28.32)	35.00 (36.27)	52.50 (46.43)	0.00 (0.00)	27.50 (31.63)	45.00 (42.13)	55.00 (47.87)	0.42 (3.7)	35.42 (36.52)	52.08 (46.19)	70.00 (56.79)
T6- Custard apple seed extract @ 6.0 %	5.00 (12.92)	35.00 (36.27)	80.00 (63.44)	92.50 (74.11)	0.00 (0.00)	32.50 (34.76)	85.00 (67.21)	95.00 (77.08)	4.17 (11.78)	45.83 (42.61)	85.00 (67.21)	93.75 (75.52)
T7- Neem oil @ 1.0 %	0.00 (0.00)	5.00 (12.92)	25.00 (30)	45.00 (42.13)	0.00 (0.00)	12.50 (20.7)	22.50 (28.32)	52.50 (46.43)	0.00 (0)	22.08 (28.03)	37.08 (37.51)	56.25 (48.59)
T8- Neem oil @ 1.5 %	2.50 (9.10)	15.00 (22.79)	37.50 (37.76)	60.00 (50.77)	2.50 (9.1)	20.00 (26.57)	35.00 (36.27)	60.00 (50.77)	2.08 (8.3)	28.75 (32.42)	48.33 (44.04)	68.33 (55.76)
T9- Neem oil @ 2.0 %	2.50 (9.10)	25.00 (30.00)	57.50 (49.31)	80.00 (63.44)	0.00 (0.00)	25.00 (30.00)	60.00 (50.77)	77.50 (61.68)	2.50 (9.1)	38.33 (38.25)	75.42 (60.28)	87.50 (69.3)
T10- Untreated check	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.83 (5.24)	2.50 (9.1)	2.92 (9.83)	3.33 (10.52)
SEm±	3.36	2.68	2.29	2.98	1.46	2.79	2.45	3.09	2.85	1.38	1.16	1.48
CD	NS	7.75	6.61	8.62	NS	8.06	7.07	8.91	NS	3.99	3.35	4.27

(\* ) Figures in parenthesis are arcsine transformed value, NS=Non-Significant

**Table-3: Efficacy of different concentration of bio-pesticides on mortality of Greater wax moth**

Treatment	Mean mortality of different larval instar of <i>Galleria mellonella</i> (%)						
	I	II	III	IV	V	VI	Over all mean larval mortality
T1- Bacillus thuringiensisvar. kurstaki @ 1.0 %	37.50 (37.76)*	34.38 (35.9)	31.88 (34.37)	29.38 (32.82)	26.88 (31.23)	29.38 (32.82)	31.56 (34.18)
T2- Bacillus thuringiensisvar. kurstaki@ 1.5 %	48.75 (44.28)	45.00 (42.13)	43.75 (41.41)	43.13 (41.05)	40.63 (39.6)	43.13 (41.05)	43.65 (41.35)
T3- Bacillus thuringiensisvar. kurstaki @ 2.0 %	63.75 (52.98)	61.88 (51.87)	61.25 (51.5)	56.25 (48.59)	53.13 (46.79)	56.25 (48.59)	58.65 (49.98)
T4- Custard apple seed extract@ 2.0 %	41.88 (40.32)	41.25 (39.96)	40.63 (39.6)	33.75 (35.52)	19.38 (26.11)	33.75 (35.52)	32.92 (35.01)
T5- Custard apple seed extract @ 4.0 %	47.50 (43.57)	45.00 (42.13)	46.25 (42.85)	38.75 (38.5)	27.50 (31.63)	38.75 (38.5)	39.48 (38.93)
T6- Custard apple seed extract @ 6.0 %	63.13 (52.61)	61.88 (51.87)	56.88 (48.95)	55.00 (47.87)	53.13 (46.79)	55.00 (47.87)	57.19 (49.13)
T7- Neem oil @ 1.0 %	36.25 (37.02)	35.63 (36.65)	32.50 (34.76)	28.13 (32.03)	18.75 (25.66)	28.13 (32.03)	28.85 (32.49)
T8- Neem oil @ 1.5 %	41.25 (39.96)	43.75 (41.41)	40.63 (39.6)	37.50 (37.76)	28.75 (32.42)	37.50 (37.76)	36.88 (37.39)
T9- Neem oil @ 2.0 %	59.38 (50.4)	56.25 (48.59)	55.63 (48.23)	52.50 (46.43)	41.25 (39.96)	52.50 (46.43)	50.94 (45.54)
T10- Untreated check	5.00 (12.92)	4.38 (12.07)	3.13 (10.18)	1.88 (7.87)	0.00 (0)	1.88 (7.87)	2.40 (8.9)
<b>SEm±</b>	2.08	1.89	1.80	1.97	1.17	1.97	0.76
<b>CD</b>	6.01	5.46	5.21	5.71	3.39	5.71	2.18

(\* ) Figures in parenthesis are arcsine transformed value

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