

Ecofriendly Management of Greater Wax Moth (*Galleria mellonella*) Infesting Combs Under Storage

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ABSTRACT

The greater wax moth causes greatest damage in apiaries which leads to huge financial losses every year. Besides damaging wax combs by larval feeding and destroying frames and wooden parts in the hive, adult wax moths and larvae can also transfer pathogens of serious bee diseases like foulbrood. During dearth and monsoon period, damage is increased to many folds in *Apis mellifera* and *Apis cerana* colonies. The larvae destroy raised combs in storage as well as in hives by moving into the midrib of the comb, forming tunnels heavily lined with silken material, making removal by bees difficult. Management strategies used for the control of wax moth revealed that 100% larval mortality was recorded in Deep freezer at -8 to -10°C, while treatment with sulphur fumigation resulted in 43.33 per cent larval mortality. The lowest food consumption (31.11%) and hence lowest weight gain per larvae (0.0716g) was seen in treatment with NSKE (5%). Minimum per cent adult emergence (44.83%) was recorded in treatment with Neem leaves powder. The lowest per cent infestation of combs (2.37%) was seen in case of Neem oil (3%). Neem oil (3%) and sulphur fumigation is recommended for management of wax moth in order to reduce losses in storage conditions.

Keywords: *Apis cerana*, Sulphur fumigation, Neem oil, Larval

INTRODUCTION

Apiculture in India is a very young science, and bee research was initiated in early forties of twentieth century (Sanford, 1987). Although, beekeeping is known popularly for its honey as the major produce, but there are other produce which are also good sources of income. Such produce includes; beeswax, pollen, propolis, royal jelly and venom

(DENR-CAR, 1997). Like all living organisms, honey bees can be infected/infested with diseases and pests. Some of these are more deleterious to bee colonies than others, but it is important for beekeepers to be able to recognize conditions which might be disease or pest and respond accordingly (Sanford, 1987).

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The most important of these enemies are those that destroy the combs, the stores, the hive itself and some predators that take foraging worker bees as they leave the hive, or those that behave as true parasites by raising their offspring in the bodies of bees (Ben, 1999). Greater wax moth (GWM), *Galleria mellonella* Linn. (Pyralidae: Lepidoptera), and lesser wax moth, *Achroia grisella* L., are known to be harmful to deposited and stored beeswax. Greater wax moth causes the greatest damage in apiaries which lead to financial losses every year, beside damaging wax combs by larval feeding, and destroying frames and wooden parts in the hive (Burges, 1978; Chang & Hsieh, 1992; Haewoon et al., 1995 and Smith, 1965). They feed on pollen, wax and protein of the pupal skins (Brar et al., 1985). Feeding by the larvae causes damage to comb and developing bees, a condition referred to as galleriasis (Williams, 1978). The intestines of the insect often harbour the spores of *Paenibacillus larvae*, the causative agent of American foulbrood. The spores may be released in other colonies in the faeces (Toumanoff, 1939; Charriere & Imdorf, 1997). Almost all colonies of Asian honeybees are prone to moth infestation (Adalakha & Sharma, 1975; Brar et al., 1985; Viraktamath, 1989). Normally, the wax moth attacks only abandoned beehives, or active ones in which the bee colony has been weakened. The larvae have acute sensory capability to find and exploit beeswax, destroying combs and honey. Adults do not feed since they possess atrophied mouth parts (Charriere & Imdorf, 1997).

Maximum infestation of wax moth has been recorded during July to September, generally in the brood frames and occasionally in the super frames (Gupta, 1987). Observations show that *G. mellonella* caterpillars are highly resistant to food shortage, but under deficient food conditions, their development (from egg to adult) may be extended up to 6 months. Adult insects from poorly nourished caterpillars are smaller with decreased vitality (Marston et al., 1975). In the absence of adequate food supplies the larvae of *G. mellonella* become cannibalistic (Ben,

1999). It is present throughout the world with rare exceptions in high elevations and colonies of *Apis cerana indica* have been reported to abscond due to infestation with the wax moth (Leong, 1990). During dearth and monsoon period, damage is increased to many folds in *Apis mellifera* and *Apis cerana* colonies; in *Apis dorsata*, its seasonal infestation pattern differs from the domesticated bees. Wax moth population starts building from March, reaching its peak in August (99- 100%) and then show decline till February. Moth infests all stages of brood, cells, pollen and honey region. Wax moth larvae can reduce the combs to a mass of web and debris. Severe infestation leads to suspension in brood rearing, foraging activity and ultimately desertion of colony from the nest (Thakur, 1991).

The first line of defence against wax moth warrants their continuous monitoring and recognition of early stages of infestation so that preventive measures could be initiated well in advance before any devastation occurs. Preventing measures for wax moth infestation include ensuring that the colonies are strong and have adequate food storage, reducing the hive entrance and sealing cracks and crevices in the wall, and removing wax debris accumulated on the bottom boards of the hives (Ritter & Akratanakul, 2006).

Use of chemical insecticides such as para dichloro benzene and calcium cyanide is harmful to bee population. Different chemicals such as moth balls, particularly the Naphthalene and PDB (Para Dichlorobenzene) have been used as insecticides at the larval stage. But these measures may not be safe due to the residuals which are left behind, polluting the wax, making it difficult to use for domestication and baiting new hives for colonization (Babarinde et al., 2013).

Use of plant products as a safe alternative of chemicals is emerging as a major thrust area in controlling greater wax moth all over the world (Alkofahi et al., 1989; Hiremath, 1994). Botanicals have high insecticidal activity against the larvae of *G. mellonella* (Bolchi, 1979; Eischen & Dietz, 1987). To control the menace of the wax moth, various researchers have been working but

very little information is available on the comparative efficacy of different plant products against the larvae of the greater wax moth, *G. mellonella*. It is of paramount importance that beekeepers should be aware of these limiting factors and can well protect their colonies to get maximum benefit from beekeeping venture.

MATERIALS AND METHODS

Materials:

Test insect: Greater wax moth (*Galleria mellonella* Linnaeus; Pyralidae: Lepidoptera), 2nd instar.

Testing material: 1. Sulphur fumigation, 2. Neem oil (3%), 3. Dried neem leaves powder, 4. Deep freezer at -8 to -10°C, 5. Neem Seed Kernel Extract (5%), 6. Karanj oil (3%).

Feeding material: Wax combs (17x8cm²) from uninfested hives.

Methods:

The experiments were carried out in Apiculture lab, Department of Entomology, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, Udham Singh Nagar- 263145 (Uttarakhand) to study the life cycle and management of greater wax moth (*Galleria mellonella*) in *Apis mellifera* combs under storage conditions during the year 2012-2013.

1. Maintaining culture of greater wax moth

Naturally-infested wax combs of *Apis mellifera* with greater wax moth were obtained from the hives of apiary of G.B Pant University and were taken to a rearing chamber in the same facility. The combs were examined for the presence of eggs, larvae, pupae and adults of wax moth. If any of the stages was found in debris of combs and/or on combs, the hive was considered to be infested. Infested wax combs were cut and transferred to clean 5 kg-glass jars, supplied with the wax from old combs as food for developing larvae under laboratory conditions (28±5°C temperature and 65±5% RH). Emerged moths were then transferred into new jars with uninfected waxes and allowed to copulate and lay eggs. Cuttings of hard white paper folded at several angles were transferred to the jars to

provide substrate to the females for egg laying. Homogeneous larvae were used for management studies.

2. Bioassay

The uninfested wax combs were cut in size of 17x8cm², treated with testing material and transferred to glass jars (5kg) in replication of three in a completely randomized design (CRD).

T1: Sulphur fumigation

Wax combs were treated with Sulphur dust (0.5g/m³). Ten larvae of 5d old *G. mellonella* (mean larval wt. =0.0036g) were supplied in each jar. The treated combs were kept in jars (5kg) and air tight conditions were maintained with the help of polythene, bind with adhesive tape.

T2: Spray with Neem Oil (3%)

The neem oil (3%) solution was prepared by mixing commercially available neem oil in tap water. Teepol (5ml/l) was added to this solution as sticker. The combs were sprayed with this solution with the help of a Collin hand sprayer and were left to dry for 20 minutes. Ten larvae of 5d old *G. mellonella* (mean larval wt. =0.0052g) were transferred into each jar.

T3: Dusting with Dried Neem leaves powder

Fine powder of the shade dried neem leaves was applied at the rate of 8.33g/comb and ten larvae of 5d old *G. mellonella* (mean larval wt. =0.004g) were transferred into each jar. The jars were covered with polythene bind with adhesive tape to create air tight conditions.

T4: Deep freezing at -8°C to -10°C

Ten larvae of 5d old *G. mellonella* (mean larval wt. =0.0013g) were transferred to each comb in three replications. The jars containing wax combs were kept in deep freezer at -8°C to -10°C.

T5: Spray with Neem Seed Kernel Extract (5%)

Extract of neem seed kernels (5%) was prepared and the combs were treated with the fermented NSKE by spraying with the help of Collin's hand sprayer. The combs were allowed to dry for 20 minutes. Ten larvae of 5d old *G. mellonella* (mean larval wt. =0.0065g) were transferred to each comb and

these combs were then transferred to jars. The jars were covered with muslin cloth.

T6: Spray with Karanj Oil (3%)

A spray solution of Karanj oil (3%) was prepared by adding 3 ml of Karanj oil (100%) to 97 ml water. Teepol (5ml/l) was added as a sticker to let the oil mix in water properly and the solution was mixed properly by stirring with a glass rod. The combs were dipped in Karanj oil solution and allowed to dry for 20 minutes. Ten larvae of 2nd instar *G. mellonella* (mean larval wt.= 0.0038g) were transferred to each jar.

Effect on survival

The number of larvae were kept up to ten to avoid cannibalism among the insects. Combs in control were kept without any treatment. Ten larvae of 5d old *G. mellonella* were transferred to each jar. Observations on larval mortality, per cent feeding/infestation and weight gain/larva were taken at 7 days interval upto 28DAT. The moribund larvae were counted as dead and the per cent larval mortality was corrected using Abbott's formula. Three replicates of each treatment were established and the whole establishment was kept under laboratory conditions (28°C, 80±2% R.H).

Effect on growth and development

To evaluate the effect of treatments on growth and development of *G. mellonella*, per cent weight gain by the larvae over control (7 & 14DAF), pupal period, per cent pupation, per cent adult emergence and adult longevity were recorded. Shape and wing span of emerged adults was observed to confirm any kind of deformities in the adult insects. The weight of wax combs and tunnel length (cm) were also recorded at every 7th day to mark per cent feeding and area of infestation by the larvae, respectively. The data recorded was analyzed using STPR-3 and to compare the treatments, DMRT (Duncans Multiple Range Test) was carried out.

Effect on feeding and per cent infestation

The wax moth infestation in live colonies of honeybees or in stored combs is clearly visible as the infestation is marked by the presence of silken thread on the surface of combs, along with the feeding tunnels inside the combs. The

per cent infestation could be calculated by using the length of tunnel and hence the volume of wax comb consumed by the larvae. During the present experiment, length of tunnel inside the combs was recorded at seven days interval and the volume of wax comb was calculated on the basis of the fact that the volume of a wax comb used for larval feeding in this experiment was 272 cm³ [2×(17cm×8cm×2cm)]. The tunnels in comb due to feeding of wax moth were in the form of cylinder and hence volume consumed by the wax moth was measured as the volume of a cylinder ($\pi r^2 h$).

RESULTS AND DISCUSSION

Management of the greater wax moth *Galleria mellonella* (L.)

Treatment-mortality response:

Larval mortality: The highest larval mortality (100 %) was seen in case of T4 (deep freezer at -8 to -10°C) at 7DAF. All of the ten larvae were found dead and no further infestation was seen in wax combs. T1 (Sulphur fumigation) resulted in 33.33 per cent larval mortality, followed by 23.33 per cent in T6 (Spray with Karanj Oil 3%) and 20 per cent in T2 (Spray with Neem Oil 3%) and T5 (NSKE 5%). The minimum larval mortality (16.66%) was recorded in T3 (Dusting with dried neem leaves). Statistical analysis with DMRT (Duncan's Multiple Range Test) showed that the larval mortality in T2, T3, T5 and T6 were at par. Treatment with deep freezer (T4) showed highly significant larval mortality as compared to all the other treatments. No further infestation was recorded in T4 as all the larvae were already dead. Besides T4, T1 showed the highest mortality of 43.33 per cent at 14DAF. Among T2, T3, T5 and T6, no significant difference and showed similar larval mortality (26.66%) (Table-1). Shimanuki et al. (1997) recommended the use of Deep Freezer for the control of wax moth. They specified minimum cold temperature and storage time required to kill all life stages of wax moths in honey-extracted comb, include as 20°F (-7°C) for 4.5 hours, 10°F (-12°C) for three hours, or 5°F (-15°C) for two hours. The British Beekeepers Association (2012) also

supported the view that deep freezing of combs is an effective method of wax moth control. According to them, if a large chest freezer is available the combs can be frozen and this prevents egg hatching, kills caterpillars and prevents combs from being re-infested.

Results on larval mortality observed in T1 (Sulphur fumigation), T2 (Neem oil), T3 (dried neem leaves, T5 (NSKE) and T6 (Karanj oil) were in accordance with those of Sattigi et al. (1990) who reported the effectiveness of smearing of hive with lime sulphur paste on wax moth infestation. The treatment provided 78% protection to colonies from wax moth attack. Swamy et al. (2006) evaluated the efficacy of NSKE and Karanj oil against the larvae of the greater wax moth and observed 11.78 and 56.42% larval mortality, respectively. Haq et al. (2008) conducted an experiment on effect of aqueous extract of neem seed at different concentrations (0.5, 1, 2, 3 and 4%) against greater wax moth, (*G. mellonella*). The highest mortality (83.33%) of greater wax moth was observed with 4% neem seed extract (NSE) while minimum (50%) mortality was found with 0.5% neem seed extract. Bhopale et al. (2013) subjected different larval instars of *G. mellonella* to botanicals and microbial pesticides viz., dried neem leaf, neem oil 3 per cent, *Bt kurstaki* (Halt), *Bt* local strain-1 and *Bt* (Halt.) local strain-2, pongamia oil 3 per cent and NSKE 5 per cent. Among these *Bt kurstaki* and pongamia oil gave maximum larval mortality (93.33%).

Pupal mortality and adult emergence:

Observations on per cent pupal mortality were recorded 35 days after treatment. Since the larvae in the T4 (Deep freezer) did not go under pupation, no observation at pupal stage was possible. Highest pupal mortality (55.15%) was recorded in case of T3 (Dried neem leaves powder) and lowest mortality (21.69%) was observed in T7 (control). The deviation of treatments from mean was as 48.61% mortality in T5 (5% Neem Seeds Kernel Extract), 42.85% in T2 (3% neem oil), 39.52% in T1 (Sulphur fumigation) and 38.09% in case of T6 (3% Karanj oil). As a

result of feeding on treated combs, metabolism of larvae may be affected and the process of conversion of pupa to adult may be either extended or complete pupal death may occur. The death of insect in pupal stage prevents the emergence of the adults. The longevity and fecundity of adults may also be adversely affected by the action of plant derivatives on the physiology and nervous system of the insects. Adult emergence is inversely proportional to the pupal mortality. Greater the number of dead pupae lesser will be the number of emerging adults. Lowest adult emergence (44.83%) was recorded in case of T3, which was followed by T5 (51.385), T2 (57.13%), T1 (60.47%) and T6 (61.9%). Highest adult emergence (78.30%) was seen in case of T7. All the treatments were at par and resulted in statistically equal pupal mortality and adult emergence, hence no significant difference was seen in among treatment (Table-1). Blaney et al. (1990) reported a completely different mode of action of salinins and nimbin than azadirachtin. The effects of one or more secondary compounds in neem seed extracts include egg sterility, oviposition repellency and inhibition of chitin biosynthesis (Ascher, 1993).

Effect of treatments on growth and development of the greater wax moth

Effect on weight gain by insect: In case of T3 (Dusting with dried neem leaves powder), the average weight of 30 larvae after seven days was 0.0336g as compare to their initial weight (0.004g). Besides T4, the lowest weight gain (0.0296g) was recorded in T3, followed by 0.0324g in case of T6 (Sprayed with 3% Karanj oil), 0.0353g in T5 (Spray with 5% NSKE), 0.04g in T1 (Sulphur fumigation) and 0.0526g in T2 (Sprayed with 3% neem oil). No weight gain by the larvae was seen in case of T4 (deep freezer) as the larvae were found dead within 24 hours of treatment. The highest weight gain (0.0619g) after seven days was seen in case of T7 (Control). The treatment with dried neem leaves (T3) was statistically similar to T1, T3, T5, and T6, but it resulted into significantly lower weight gain by the larvae when compared to T2. However, fourteen days after treatment no further

observations were needed as all the 30 larvae in three replications were already dead in T4. Lowest weight gain (0.0716g) was recorded in T5, where the average weight of the larvae was recorded to be 0.0781g as compare to their initial weight (0.0065g). This weight gain was followed by 0.0885g in case of T3, 0.0912g in T2, 0.0954 in T1 and 0.1101g in case of T6. The weight gain in control was recorded as 0.1201g. The treatments T1, T2 and T3 were at par 14DAF. The treatment with NSKE 5% (T5) resulted in statistically equal weight gain as compared to T3, but showed significantly lower weight gain when compared with T1 and T2. This shows that our testing material had a negative effect on larval feeding (Table-1).

Effects on larval and pupal period: The minimum larval period (14 days) was observed in case of T7 (Control). This could be explained on the basis of the fact that feeding on the treated combs slowed down the development of the larvae. The larvae which survived against the toxic effects of the tested materials faced difficulty to combat the treatments, hence took more time to reach up to maturity as compared to control where they were fed upon the untreated combs where they completed their larval period within 14 days. The extended larval period with low food consumption is thought to be a result of negative effect of treatments on the metabolic process of the larvae (Table-1).

These results are supported by Ascher (1993); Mordue and Blackwell (1993), they reported that Azadirachtin showed anti-feedant effects on insects. Among insects, order Lepidoptera was found to be the most susceptible to azadirachtin as compared to other orders viz. Coleoptera, Hemiptera and Homoptera, which were found less susceptible. A study by Mordue and Blackwell (1993) on the effect of azadirachtin on tissues of some insects showed that the application of azadirachtin caused most of the insects to lose their vigour or fitness. According to Dorn et al. (1987), the fitness of insects is often reduced after application of low dosages of azadirachtin. Ascher (1993) reported that besides azadirachtin, a large number of

compounds are present in extracts of neem seed that also exhibit biological actions.

Effects of treatments on food consumption and comb infestation by *Galleria mellonella* larvae

Weight of combs: Minimum per cent weight loss (1.04%) of combs was recorded in T4 (Deep freezer at 8-10⁰C), followed by 13.14% in T1 (Sulphur fumigation), 17.21% in T5 (Sprayed with 5% NSKE), and 18.14% in T6 (3% Karanj oil) at 7DAT. The highest weight reduction of comb's weight (20.68%) was seen in control. The treatments T2, T5 and T6 were statistically at par. Treatment with Deep freezer (T4) resulted in significantly lower weight loss when compared to all the other treatments. The treatment with sulphur (T1) showed statistically equal weight loss as compared to T2, T5, T6 and but it resulted in significantly lower weight loss when compared to control (Table-1).

The minimum comb's weight loss (26.41%) was recorded in T5 and the control again showed the highest comb's weight loss (38.09%) at 14DAT. The weight loss in T2, T3, T5 and T6 were at par. T5 resulted in statistically equal weight loss when compared to T3, but it showed significantly lower weight loss as compared to T1, T2, T5 and T6.

Tunnel length and per cent comb infestation: Minimum length of tunnel (4.33 cm) was recorded in (Deep freezing at -8 to -10⁰C) at 7DAT, since the larvae were dead within 24 hours at this freezing temperature. No further change in tunnel length, volume consumed and per cent infestation was seen in T4. The comb volume consumed by the larvae was recorded as 0.13 cm³ and the per cent infestation was 0.04%. The tunnel length in T1, T3, T5 and T6 were at par. T4 resulted in significantly least tunnel length (4.33 cm) when compared to T1 (40 cm), T2 (30.66 cm), T3 (42.66 cm), T5 (43.33 cm) and T6 (42.33 cm). Maximum tunnel length (56 cm) was recorded in control. The volume of wax combs infested during this period was observed minimum (0.13cm³) in T4 and maximum (7.03cm³) in control. The treatment with Neem oil 3% (T2) resulted in statistically significant lower infested volume (3.85 cm³) as compared

to T1 (5.01 cm³), T3 (5.35 cm³), T5 (5.44 cm³) and T6 (5.31 cm³). T2 showed significantly lower per cent infestation when compared to T1, T3, T5 and T6; however, it showed significantly higher per cent infestation when compared with T4.

Observations recorded fourteen days after treatment, minimum tunnel length (49 cm) was recorded in T2, followed by T1, T5 and T6. The maximum tunnel length (75.33 cm) was observed in control. The tunnel length in T2 and T3 resulted in statistically similar but significantly reduced when compared to T5 and T6. Among all the treatments, T2 resulted in minimum tunnel length (49 cm), hence minimum volume infestation (6.15 cm³). T1, T5 and T7 resulted in higher infested volume of wax combs. The highest volume infestation was seen in control (8.96 cm³) (Table-1). The observations in the present study on the weight of mature larvae is very important considering the fact that they can be an ideal for the observation regarding the

efficacy of testing material on the feeding behaviour of different instars of the greater wax moth. This could be explained on the basis of the fact that plant derivatives may act as anti-feedant or feeding deterrent.

The adverse effects of azadirachtin extract obtained from ripe fruits, seeds, trunk and flower of *Melia azedarach* and *Azadirachta indica* on total glycogen amount of *Galleria mellonella* were observed by Sezer and Ozalp (2011). The insect growth regulation effects of azadirachtin manifest as developmental aberrations in immature insects, and are both dose and time dependent; can cause death before and during the moult, or delay of the moult (Rembold, 1995). Azadirachtin showed anti-feedant effects on insects. Among insects, order Lepidoptera was found to be the most susceptible to azadirachtin as compared to other orders viz. Coleoptera, Hemiptera and Homoptera, which were found less susceptible (Ascher, 1993; Mordue & Blackwell, 1993).

Table 1: Effect of different treatments on growth of *Galleria mellonella* larvae

Treatments	Mean larval weight (initial, gm)	Per cent larval mortality		Mean weight gain over control (%)		Per cent comb infestation		Per cent weight loss in comb over control		Per cent pupal mortality	Per cent Adult emergence
		7 DAF	14 DAF	7 DAF	14 DAF	7DAF	14DAF	7DAF	14DAF		
T1: Sulphur fumigation	0.0036 ^c	33.33 ^b	43.33 ^a	0.04 ^{ab}	0.0954 ^b	1.84 ^c	2.62 ^{bc}	13.14 ^b	33.75 ^{bc}	39.52 ^a	60.47 ^a
T2: Sprayed with Neem Oil (3%)	0.0052 ^{bc}	20 ^{ab}	26.66 ^a	0.0526 ^b	0.0912 ^{bc}	1.41 ^b	2.25 ^b	19.08 ^{bc}	33.30 ^{bc}	42.85 ^a	57.13 ^a
T3: Dried Neem leaves	0.004 ^b	16.66 ^{ab}	26.66 ^a	0.0296 ^{ab}	0.0885 ^{bc}	1.96 ^c	2.38 ^b	20.68 ^{bc}	29.18 ^c	55.15 ^a	44.83 ^a
T4: Deep Freezer at -8 to -10°C	0.0013 ^a	100 ^c	100 ^c	0.00 ^a	0.00 ^a	0.04 ^a	0.04 ^a	1.07 ^a	1.07 ^c	-	-
T5: Sprayed with NSKE (5%)	0.0065 ^b	20 ^{ab}	26.66 ^a	0.0353 ^{ab}	0.0716 ^b	1.98 ^c	2.92 ^{cd}	17.22 ^{bc}	26.41 ^c	48.61 ^a	51.38 ^a
T6: Sprayed with Karanj Oil (3%)	0.0038 ^b	23.33 ^{ab}	26.66 ^a	0.0324 ^{ab}	0.1101 ^{cd}	1.94 ^c	2.74 ^{bc}	18.14 ^{bc}	31.95 ^{bc}	38.09 ^a	61.9 ^a
CONTROL	0.0039 ^b	10 ^a	23.33 ^a	0.0619 ^b	0.1201 ^d	2.58 ^d	3.29 ^d	23.10 ^c	38.09 ^b	21.69 ^a	78.30 ^a
SEM	0.0007	31.90	39.04	0.014	0.006	1.67	2.32	16.06	27.67	40.98	59.00
Cd at 5%	0.002	6.88	6.63	0.04	0.02	0.12	0.15	3.14	3.10	10.87	10.87
CV		21.20	19.14			0.37	0.46	9.69	9.61	34.27	31.93

CONCLUSION

Present studies on management of wax moth revealed that after 14 days of feeding, lowest weight gain (0.00g) by the larvae was recorded in Deep freezer at -8 to -10°C (T4). However, it was a less practical method. The second lowest weight gain (0.0716g) was seen in T5 (NSKE 5%), while the highest weight gain (0.12g) by the larvae was seen in control. From the larval mortality point of view, T4 was found most effective as all of the 30 larvae were dead within 24 hour of treatment. Besides T4, treatment with sulphur fumigation (T1) proved to be most effective by killing 43.33 per cent larvae as compared to control (23.33%). Treatment with Neem leaves powder (T3) resulted in lowest per cent adult emergence (44.83%), while maximum adult emergence (78.30%) was observed in control. T4 showed minimum weight loss and food consumption since the larvae died earlier. After T4, the minimum food consumption was observed in T5 (NSKE 5%) which resulted in minimum weight loss (31.11%) of comb, while maximum food was consumed in control and it resulted in 48.07 per cent reduction in comb weight. The lowest per cent infestation (0.04%) was seen in the treatment T4. Besides T4, the lowest per cent infestation (2.37%) was seen in case of T2, while maximum infestation was recorded in control (3.48%) (Table-1). For management of the greater wax moth in order to reduce losses in storage conditions, it is recommended that the combs should be treated with Neem oil (3%) or Sulphur fumigation should be done.

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