RESEARCH ARTICLE

Evaluation of Structural Modifications on Bee Hives Using Different Types of Bottom Board Materials Against Greater Wax Moth *Galleria mellonella* L. (Pyralidae, Lepidoptera) Infesting On *Apis cerana indica* F. Colonies

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ABSTRACT

The greater wax moth, *Galleria mellonella* caused damage to honey bee colonies resulting in heavy economic losses to beekeepers. The present study entitled "Evaluation of structural modifications on Bee hives using different types of bottom board materials against greater wax moth *Galleria mellonella* L. (Pyralidae, Lepidoptera) infesting on *Apis cerana indica* F. Colonies". The results revealed that the Incidence of wax moth larvae on different treatments on the bottom board, laminated with mica, showed significantly ($p<0.05$) effective with less wax moth larvae (1.00), which was followed by bottom board laminated with glass plate (1.44). The Incidence of wax moth pupae on different treatments on bottom board laminated with mica was significantly ($p<0.05$) superior with the least wax moth pupae (0.88), which was followed by glass plate (1.88), cardboard (2.63), OHP sheet (2.81) in the order of effectiveness. The maximum extent of pupal population that occurred in untreated control was 3.81. The bottom board laminated with mica, shows significantly less absconding (0.25), followed by laminated with the glass plate (0.50), cardboard (0.75), OHP sheet (1.00). However, higher levels of colony absconding were recorded in the untreated control (1.50). Hence, it is concluded that the laminating bottom board with mica sheet will be maintain hygienic condition and prevent cracks and crevices, which will be unfavorable for egg laying of greater wax moths.

Keywords: *Galleria mellonella; Apis cerana indica; Bottom board; Mica sheet and Marthandam hive bottom board*

INTRODUCTION

A tropical country like India has an advantage over other countries as it has a wide variety of flora and a suitable climate for beekeeping throughout the year. In the Hymenoptera order, the superfamily Apoidea containing an estimated 25,000 described species belonging to 250 genera and 13 families, is regarded as the most important insect pollinators. The tremendous scope for increasing the bee colonies for honey and wax production and also for the pollination of crops. The foraging behavior of honey bees enhances agricultural productivity through cross-pollination (Anandhabhairavi *et al*., 2020).

Five species of honey bees are found all over India, namely *Apis flora, Apis cerana, A.dorsata, A.mellifera,* and *Trigona iridipennis.* However, only *Apis cerana* and *A. mellifera* were reared in hives. Many factors like pests, diseases, parasites, pesticides, and the environment influence the beekeeping honey bee population. These factors act alone or in combination with each other (Meixner, 2010). Several natural enemies like wax moths, mites, hive beetles, ants, wasps, and birds affect Honey bees, which causes considerable losses (Paddock, 1981).

Among all the species of wax moth, the greater wax moth (*Galleria mellonella* L.) (Lepidoptera: Pyralidae) is well distributed all over the world, and it affects the bee hives throughout the year (Kushram *et al*., 2022). The greater wax moth is responsible for heavy economic losses reaching up to 60 to 70 per cent to beekeepers in developing countries (Hanumanthaswamy *et al.,* 2009). The larvae often destroy the unprotected combs in storage or colonies (Kebede *et al*., 2015). The larvae build their silken-lined feeding tunnels in the honeycomb and feed on wax, pollen, and faeces around the cocoon of bee larvae (Hosamani *et al*., 2017). This voracious nature of the larvae leads to the destruction of the honeycomb and the subsequent death of weak colonies (Negi *et al*., 2019). Adults do not feed on wax combs (Charriere and Imdorf, 1997). In India, the greater wax moth also caused damage to honey bee colonies, resulting in heavy economic losses to beekeepers (Kapil and sihag, 1983 Hanumanthasamy *et al.,* 2009).

Biological, chemical methods can control the greater wax moth. But most of these methods are either inefficient or expensive for small-scale beekeepers (Tsegaye *et al*., 2014). In addition, most chemical methods were associated with residue problems in honeybee products (pirk *et al*., 2016). As a result, it is necessary to control wax moths by improving the structural integrity of the hives, as floorboard detritus attract wax moths when the colony becomes weak and the combs are not replenished. This study was done to reduce the infestation of wax moths in *A. cerana* colonies as a management approach due to a lack of information on the physical method of wax moth management.

MATERIAL AND METHODS

Description of the study site

The field experiments were conducted at the apiary of the Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli, at Tamil Nadu Agricultural University [(10.7554°N, 78.6054°E, 279'(85m)] above mean sea level). In Tiruchirappalli, winter is cold and summer is extremely hot, with an average annual maximum and minimum temperature of about 39.8°C and

26.5 °C, respectively. Mean annual precipitation is about 452.6 mm, which is received from October to December.

Studies on different types of bottom board

The greater wax moth lays eggs on the bottom board, and attempts were made to study any differences in egg laying on the bottom board lined with a glass plate, OHP sheet, mica sheet, and card board were used as treatments. The Marthandam hive bottom board was taken as the control. The observation was taken on weekly intervals. The experiment was laid out in Randomized Block Design, comprising of five treatments and four replications.

T1 – Bottom board laminated with glass plate
T2 - Bottom board laminated with OHP sheet
T3 – Bottom board laminated with mica sheet
T4 - Bottom board laminated with cardboard
T5 - Marthandam hive bottom board (Control)

Bottom board laminated with glass plate

The Marthandam hive bottom board was taken, and the glass plate (1 cm) thickness was placed over the bottom board using Fevicol SR gum. The border space between the bottom board and glass plate was sealed using plaster of paris. The edge of the bottom board was wrapped using black tape on all four sides. It was placed on bottom of the hive.

Bottom board laminated with overhead projector sheet (OHP sheet)

The Marthandam hive bottom board was taken, and the overhead projector sheet (100 micron) was laminated using Fevicol SR gum. The gap on the edges was sealed using plaster of paris. All four sides of the bottom board was wrapped with tape and placed in the hive.

Bottom board laminated with mica sheet

The Marthandam hive bottom board was taken, and mica (1 mm) sheet was placed over it and pasted with Fevicol SR gum. The empty space was sealed using plaster of paris. The edge of the bottom board was wrapped using tape on all four sides. It was placed on a bottom of the hive.

Bottom board laminated with cardboard

The Marthandam hive bottom board was taken and cardboard (0.5 mm) thickness was placed over it and pasted with Fevicol SR gum. The empty space was sealed using plaster of paris. The edge of the bottom board was wrapped using tape on all four sides. It was placed on the bottom of the hive.

Statistical analysis

Statistical analysis for various experiments was done using AGRES- AGDATA software. The data of various results of laboratory experiments were subjected to a completely randomized design. The data obtained on the mean number of greater wax moth captured were analyzed after square root (X + 0.5) transformation (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

A perusal of data in Table 1 revealed that the incidence of wax moth larvae on different treatments on bottom board, laminated with mica, showed significant ($p<0.05$) effective less number of wax moth larvae (1.00), which was followed by bottom board laminated with glass plate (1.44), bottom board laminate with cardboard (2.25), OHP sheet (2.44) in the order of effectiveness. Maximum extent of wax moth larval population was witnessed in the untreated control (3.81).

The Incidence of wax moth pupae on different treatments on bottom board laminated with mica was significantly ($p<0.05$) superior with least number of wax moth pupae (0.88), which was followed by glass plate (1.88), cardboard (2.63), OHP sheet (2.81) in the order of effectiveness. The maximum extent of pupal population occurred in untreated control (3.81), and shown least effect among the treatments presented in the table. 2.

A perusal of pooled data is presented in figure. 1. It indicates that bottom board laminated with mica shows significantly less absconding (0.25), followed by laminated with the glass plate (0.50), cardboard (0.75), OHP sheet (1.00). However, higher levels of colony absconding recorded in the untreated control (1.50). This study was aimed to create an unfavorable condition for egg laying by the greater wax moth in the bottom board (Pokhrel *et al*., 2006). Earb (1925), Kannagara (1940) and Adamson (1943) observed that the moths emerged during dusk and were attracted to wax present in the hives, eggs were laid in any place in the hive, preferably in cracks and crevices and larvae after hatching from the eggs reached the combs.

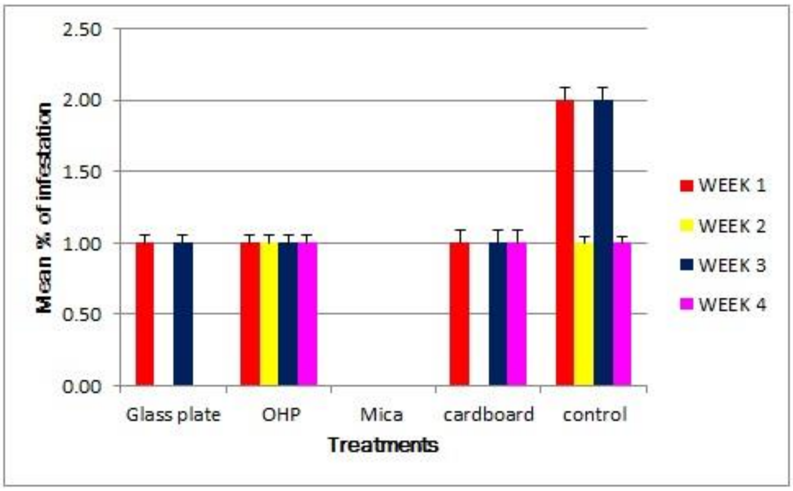

Figure 1. Absconding colonies of *Apis cerana indica* on different laminated bottom board

The current findings are consistent with those of (Edward, 2019), who found that keeping a screened bottom board over a wooden bottom board and sealing it with a laminated white sheet in between the two boards significantly increased the effectiveness of reducing wax moth infestation in A. cerana colonies. Rinderer *et al*., (2003) invented the metal screened bottom for Varroa mite management because it prevents bee-dislodged mites from falling on the wooden bottom board, naturally or after dusting powdered sugar, from re-infestation by clinging to the incoming bees (Fakhimzadeh, 2001).

Whitcomb (1936) and Kannagara (1940) advocated the removal of propolis, bur combs and refused on the bottom board, as these attracted the moths for oviposition and a shelter for the larvae. The present study shows the mica sheet can be used to laminate the floor board to avoid cracks and crevices and maintain hygienic conditions. Babarinde *et al.,* (2010) observed sealing cracks and crevices of the hive with lime Sulphur giving good results.

CONCLUSION

Wax moths remain a frustrating source of problems for beekeepers and honey bee colonies in the globe and country at large and the study area in particular. Recently, the number of investigations related to wax moth control has dropped significantly without suggestions referring to applicable backgrounds for developing countries attempting to supply organic hive products. This might be primarily due to the perception of wax moths as a secondary pest of the bee colonies and their importance in rural beekeeping farmers in those developing countries. Laminating bottom board with mica sheet will maintain hygienic condition and prevent cracks and crevices, which will be unfavorable for egg laying of greater wax moths. However, we are confident that adding these early-stage verified preventive methods through our paper to the research.

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Ethics statement

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There were no conflict of interest in the publication of this content

Originality and plagiarism

This is original research work and any work and/or words of others, has been appropriately cited

Data availability

All the data of this manuscript are included in the MS. No separate external data source is required.

Author contributions

Idea conceptualization- PJ, Experiments- PJ, Guidance –PJ, NA, Writing original draft – PJ, NA, Writing-reviewing &editing – PJ, NA.

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Table 1. Influence of different laminated bottom board on the *Galleria mellonella* in *Apis cerana indica and* Incidence of wax moth larva

Treatments	Mean % of infestation				Mean
	1st week	2nd week	3rd week	4th week	
Glass plate	2.00 (1.39)	1.75 (1.31)	1.00 (1.00)	1.00 (1.00)	1.44 (1.17)[b]
OHP	1.75 (1.29)	4.25 (2.06)	2.75 (1.65)	1.00 (1.00)	2.44 (1.50)[c]
Mica	1.00(1.00)	1.00 (1.00)	1.00 (1.00)	1.00 (1.00)	1.00 (1.00)[a]
Cardboard	3.75 (1.92)	1.00 (1.00)	1.00 (1.00)	3.25 (1.80)	2.25 (1.43)[c]
Control	6.00 (2.44)	2.50 (1.57)	2.75 (1.65)	4.00 (1.99)	3.81 (1.91)[d]
Mean	2.90 (1.61)[c]	2.10 (1.39)[b]	1.70 (1.26)[a]	2.05 (1.36)[ab]	

The counts are mean of four replications; Figures in parenthesis are square root(X+0.5) transformed values; CD (P = 0.05)

Between Treatments	:	0.11**
Between Counts	:	0.99**
Treatments x Counts	:	0.22**

Table 2. Influence of different laminated bottom board on the Incidence of wax moth pupae, *Galleria mellonella*

Treatments	Mean % of infestation				Mean
	1st week	2nd week	3rd week	4th week	
Glass plate	4.00 (1.99)	2.00 (1.41)	0.50 (0.71)	1.00 (1.00)	1.88 (1.27)[b]
OHP	3.00 (1.72)	4.00 (1.98)	2.25 (1.49)	2.00 (1.40)	2.81 (1.65)[d]
Mica	2.00(1.43)	0.25 (0.50)	0.25 (0.50)	1.00 (1.00)	0.88 (0.86)[a]
Cardboard	3.00 (1.75)	0.50 (0.72)	3.00 (1.75)	4.00 (2.02)	2.63 (1.56)[c]

Control	8.00 (2.83)	3.00 (1.74)	2.00 (1.42)	2.25 (1.50)	3.81 (1.87)[e]
Mean	4.00 (1.94)[d]	1.95 (1.27)[b]	1.60 (1.17)[a]	2.05 (1.39)[c]	

The counts are mean of four replications; Figures in parenthesis are square root(X+0.5) transformed values; CD (P = 0.05)

Between Treatments	:	0.03**
Between Counts	:	0.03**
Treatments x Counts	:	0.06**