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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 which results 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 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 were significantly ($p<0.05$) superior with 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 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 recorded in the untreated control (1.50). Hence, it is concluded that the laminating bottom board with mica sheet will maintaining hygiene condition and prevent cracks and crevices which will be unfavorable for egg laying of greater wax moth.

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

INTRODUCTION

A tropical country like India has an advantage over other countries as it has a rich 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 group of insect pollinators. The great scope for increasing the bee colonies for honey and wax production and also for pollination of crops. Forging behaviour of honey bees enhance the agricultural productivity through cross-pollination (Anandhabhairavi *et al*., 2020).

There are 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. The beekeeping honey bee population is influenced by many factors like pests, diseases, parasites, pesticides, and the environment. These factors act alone or in combination with each other (Meixner, 2010). Honey bees are affected by several natural enemies like wax moths, mites, hive beetles, ants, wasps, and birds which cause 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, faeces around the cocoon of bee larvae (Hosamani *et al*., 2017). This voracious nature of the

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larvae lead 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 also, the greater wax moth caused damage to honeybee colonies which results in heavy economic losses to beekeepers (Kapil and sihag, 1983; Hanumanthasamy *et al*., 2009).

The greater wax moth can be controlled by biological, chemical methods. 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 attracts wax moths when the colony becomes weak and the combs are not replenished. This study was done to reduce the infestation of wax moth 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 [(10.7554ºN, 78.6054ºE, 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 39.8ºC and 26.5ºC 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 in bottom board attempts were made to study any differences in egg laying on the bottom board lined with glass plate, OHP sheet, mica sheet and card board were used as treatments. The Marthandam hive bottom board 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.

T_1 – Bottom board laminated with glass plate

T_2 - Bottom board laminated with OHP sheet

T_3 – Bottom board laminated with mica sheet

T_4 - Bottom board laminated with cardboard

T_5 - 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 the four sides. It was placed on a 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 by using Fevicol SR gum. The gap on the edges was sealed using plaster of paris. All the four side 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 (1mm) 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 all the 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 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 all the four sides. It was placed on a 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 completely randomized design. The data obtained on the mean number of greater wax moth captured were analyzed after square root (× + 0.5) transformation (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

A perusal of data Table 1 revealed that the incidence of wax moth larvae on different treatments on bottom board, laminated with mica, showed significantly ($p<0.05$) 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 untreated control (3.81).

The incidence of wax moth pupae on different treatments on bottom board laminated with mica were 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. Maximum extent of pupal population occurred in untreated control (3.81), and shown least

effect among the treatments which was presented in the Table. 2

A perusal of pooled data presented in figure. 1. It indicates that from 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 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.

The present results agree with those of (Edward, 2019) observed that the keeping over the wooden bottom board a screened bottom board sealed with a laminated white sheet in between the two boards was found to be significantly more effective in reducing wax moth infestation in *A. cerana* colonies. Rinderer *et al*. (2003) invented the metal screened bottom for Whitcomb (1936) and Kannagara, (1940) advocated the removal of propolis, bur combs and refuse on the Varroa mite management because it prevents bee-dislodged mites falling down on the wooden bottom board, naturally or after dusting powdered sugar, from re-infestation by clinging to the incoming bees (Fakhimzadeh, 2001). bottom board, as these attracted the moths for oviposition and also a shelter for the larvae. The present study shows the mica sheet can be used laminating the floor board to avoid cracks and crevices and maintain hygienic condition. Babarinde *et al*. (2010) observed sealing cracks and crevices of hive with lime Sulphur giving good results.

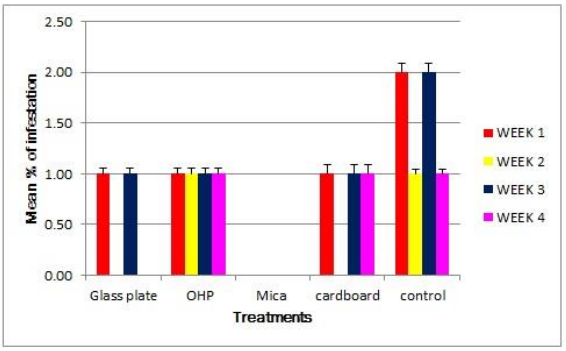

Figure 1. Absconding colonies of *Apis cerana indica* on different laminated bottom board

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**

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 who are attempting to supply organic hive products. This might be largely 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 maintaining hygiene condition and prevent cracks and crevices which will be unfavorable for egg laying of greater wax moth. 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.

Originality and plagiarism

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

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

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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