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Infestation of greater wax moth *Galleria mellonella* in *Apis mellifera* colonies in Jodhpur (Rajasthan)

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Abstract
In present study seasonal infestation of Greater wax moth *Galleria mellonella* was recorded in *Apis mellifera* colonies during February to July 2020. The results revealed that during colder months of Feb. and March there was no infestation of wax moth. The infestation was first noticed in the month of April which increased in May-June. The highest infestation was recorded in the month of July. Percentage infestation varied from 35% in the month of April to 80% in the month of July.

Keywords: *Galleria mellonella*, *A. mellifera*, infestation

Introduction
There are many enemies of honey bee hives which attacks the hives; a few to name are wasps, wax moths, ants, robber flies varroa mites etc. [15]. As reported by [11] all the species of *Apis* are attacked by *Galleria mellonella*, Greater wax moth. [3] & [5] have reported *G. mellonella* as one of the major, devastating and economically important pests for honeycomb around the world. Greater wax moth belongs to the subfamily Galleriinae, family Pyralidae and order Lepidoptera. The healthy beehives can keep the wax moth population under control by removing its larvae but a weakened beehive with small populations generally gets infested with wax moth [6] has documented March to October period as the active period of this insect-pest. The larva of *G. mellonella* feeds on combs, pollen and larva of hives in storage as well as in live honeybee colonies [4, 10]. The larvae of the wax moth after boring into the combs, crafts silken tunnels in middle of the combs, nosh on the honey, pollen, wax and brood of hives. If the infestation of wax moth is severe whole comb gets covered with webs and black fecal matter of *G. mellonella* larvae ensuing in a condition called "Galleriasis". In such cases weak bee colonies abscond leaving behind their brood, honey and pollen store. Even in strong colonies either reduction in bee population or complete obliteration of colonies has been documented [14].
In Jodhpur, Rajasthan, India while conducting pollination experiments in two forestry trees/shrubs species *viz*., *Prosopis cineraria* and *Capparis decidua* we observed infestation of wax moth in the *Apis mellifera* bee colonies. Therefore, the present investigation was done to record the incidence of *G. mellonella* in the *Apis mellifera* colonies kept for pollination in *Prosopis cineraria* and *Capparis decidua* forestry species during February to July.

Materials and Methods
The present investigation was carried out at Ecology field, AFRI, Jodhpur, Rajasthan, during February to July 2020, wherein *Apis mellifera* colonies were kept for pollination in two forestry species *viz*., *Prosopis cineraria* and *Capparis decidua*. For recording seasonal incidence of Greater wax moth *G. mellonella*, 5 colonies each with 8 bee frames strength were selected. For recording incidence of wax moth in the selected colonies each comb after brushing off the bees was held against the sunlight and observations on the number of larva, pupa and adults of greater wax moth was taken every week. Also percentage infestation was calculated using formula given below:

$$\text{Percentage infestation} = \frac{\text{Number of infested colonies}}{\text{Total number of colonies observed}} \text{x} 100$$

Randomized block design was used for the experiment and data was analyzed statistically.

Results and Discussion

Honey bee colonies were inspected for wax moth larvae, cocoon/pupa, adults and silken galleries on the brood and honey comb. It was found that weaker colonies were more susceptible to the attack of wax moth. The developmental stages of insect includes: Eggs, Larvae, Pupa and Adult. Data in the table-1 revealed that, the population of wax moth fluctuated in every month. No infestation of wax moth was recorded during February and March. The infestation was first spotted in April and then in the subsequent months the population of wax moth increased rapidly till late July during the study period. Here a slight difference is noted from the findings of [9] who reported that wax moth population starts building from March, reaching its peak in August (99-100%) and then show decline till February. This may be due to change in climatic conditions of the place of study.

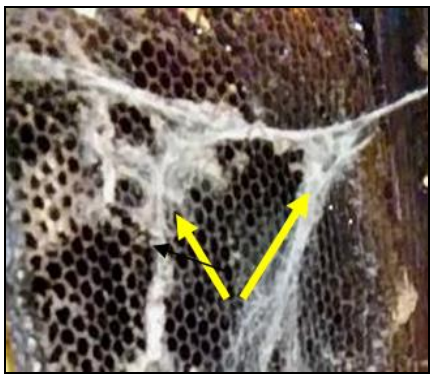
The mean population of all stages of wax moth was found highest in July (3.33) followed by June (2.833) May (1.73) and April (0.833). The results of seasonal fluctuations are in congruence with [1] who reported that population of wax moth fluctuates according to weather conditions. We observed that larval stage of wax moth was the major threat for the colonies, damaging the combs by feeding on the honey, pollen, bee brood, making silken galleries and tunnels & covering the combs with web and black fecal matter. Our data on the incidence of moth larvae were comparable to those of other studies conducted in India, indicating that a higher infestation occurred during June-July. [12] reported that though the incidence of wax moth infestation is common but the intensity of infestation depends on strength of colony and prevailing ecological conditions [13] has reported the maximum abundance of wax moth during May–November (Fig1 &2).

Percentage infestation recorded in the month of April was only 35% which increased during May-June and reached to 80% in the month of July wherein all the five honey bee boxes selected under study had infestation of wax moth (Table-2) [8] reported about 90 per cent infestation of wax moth in the combs of *A. dorsata*. However, [2] recorded 16 to 19 per cent infestation in *A. mellifera* colonies in north India.

Table 1: Population of Greater wax moth (*G. mellonella*) in *A. mellifera* colonies with 8-frame bees strength.

Month	Developmental Stages of wax moth			
	Average number of larva	Average number of pupa	Average number of adults	Mean population of wax moth
February	0	0	0	0
March	0	0	0	0
April	1.75	0.5	0.25	0.833
May	2.75	1.5	1	1.73
June	4.75	2.25	1.5	2.833
July	6	2.5	1.5	3.33
Mean	2.54	1.125	0.71	1.45
SD	2.25	1.02	0.65	1.29
SE	1.007	0.45	0.29	0.58
CV	0.97	0.99	1.00	0.97

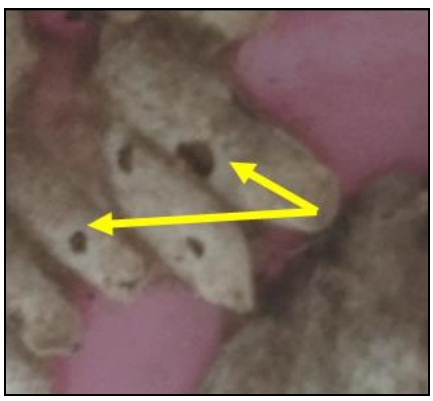
Larval stage



Silken galleries of wax moth larvae

Pupal stage

Cocoon enclosing pupal stage



Exit holes in cocoons for adult emergence

Adult stage

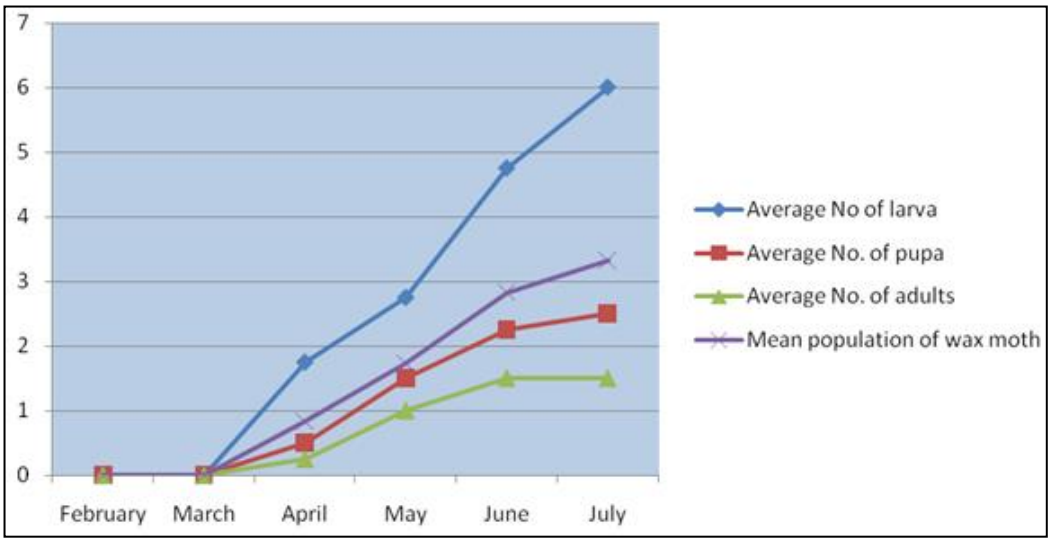


Fig 2: Seasonal variation in the population of wax moth

Table 2: Percentage infestation of wax moth in *Apis mellifera* colonies

Months	Sampling week	No. of colonies boxes inspected	No. of infested colonies	Infestation %	Average percentage infestation per month
February	Ist	5	0	0	0
	IInd	5	0	0	
	IIIrd	5	0	0	
	IVth	5	0	0	
March	Ist	5	0	0	0
	IInd	5	0	0	
	IIIrd	5	0	0	
	IVth	5	0	0	
April	Ist	5	1	20	35
	IInd	5	2	40	
	IIIrd	5	2	40	
	IVth	5	2	40	
May	Ist	5	2	40	55
	IInd	5	3	60	
	IIIrd	5	3	60	
	IVth	5	3	60	
June	Ist	5	4	80	80
	IInd	5	3	60	
	IIIrd	5	4	80	
	IVth	5	4	80	
July	Ist	5	4	80	80
	IInd	5	4	80	
	IIIrd	5	4	80	
	IVth	5	4	80	

Conclusion

Wax moth is one of the major factors accountable for absconding behavior of bee colonies. In the dry climate like Jodhpur, Rajasthan, the incidence of wax moth was more during dearth period. Seasonal incidence of *Galleria mellonella* started in the month of April and the highest number of wax moth population was recorded in July. As it causes the immense damage in apiaries leading to financial losses in addition to damage to wax combs by larval feeding, its infestation has to be checked before monsoon and management measures should be applied according to their seasonal incidence to rescue the hives and bee colonies. The installation of the yellow sticky trap may be done in the apiaries to attract adults of greater wax moth. These moths can be collected and killed to prevent the female adult from egg laying. The combs could also be sprayed with *Bt.* var. *kurstaki* formulations at the recommended doses which will check the larval population [7] reported 98.72% mortality of wax moth in honey bee colonies which was sprayed with Dipel (10% *Bt.* var. *kurstaki*), it also cosseted the honey bee combs for a period of 5.5 months from wax moth infestation. The above two are eco-friendly management measures which can be used to prevent damages to the honey bee colonies caused by wax moth. Also by proper seasonal colony management practices one can keep honey bee colony strong and healthy to avoid infestation of wax moth.

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