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POPULATION DYNAMICS OF GREATER WAX MOTH (*GALLERIA MELLONELLA* L.) INFESTING *APIS MELLIFERA* L. COMBS DURING DEARTH PERIOD

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ABSTRACT

The highest number of egg clusters (9.00), larvae (26.33), pupae (23.67) and adults' (8.00) of greater wax moth (GWM), *Galleria mellonella* L. infesting *Apis mellifera* L. combs was observed during 37th and 38th standard week in changing environmental conditions during dearth period. The highest number of GWM egg clusters, larvae, pupae and adults per hive were 34.6, 86.00, 89.67 and 30.67 respectively, observed in the month of September, which is quite more than the other months of observations. The peak month was observed as September, which lonely contributes about 32.00%, 37.28%, 37.78% and 22.01% out of total egg clusters, larvae, pupae and adults population observed during experimental period, respectively. Though, August, September and October months were observed more favourable for the incidence of GWM in *A. mellifera* L. combs and achieved 69% larval population in these months. The maximum temperature (r = 0.292**), minimum temperature (r = 0.327**) and minimum relative humidity (r = 0.322**) were positive significantly correlated with the larval population of GWM per hive, whereas the negative non-significant correlation with the maximum relative humidity and positive non-significant correlation with rainfall. Therefore, it is concluded that the GWM population are positively correlated with temperature and minimum relative humidity.

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INTRODUCTION

The beekeeping profession can be successfully adapted by well to do as well as small/marginal farmers, farm-women, landless labourers, rural unemployed youth and retired or in-service person. The initial cost to starts beekeeping is low and recurring cost is nominal (Singh and Singh, 2006). In addition to meet our local health, industry and medicine needs, this industry has a vast potential for the exports of honey and other beehive products like wax, royal jelly, bee pollen, bee venom and propolis to USA and Europe. India produces about 81,000 metric tonnes honey, out of which 29,578.52 metric tonnes exported in different country particularly to United States, Saudi Arabia, United Arab Emirates, Libya and Morocco and worth of Rs. 535.07 crore during the year of 2014-15 (Anonymous, 2015a and 2015b).

But, this industry perpetually bedeviled by a number of enemies such as wax moths, wasps, ants, beetles, robber flies, dragon flies, praying mantis, death headed moths, termites, cockroaches, mites, birds, lizards, snakes, frogs, mammals, etc. (Singh, 1975, Vishwakarma *et al.* 2012). Amongst enemies, the greater wax moth, *Galleria mellonella* L. and the lesser wax moth, *Achroia grisella* belongs to order Lepidoptera, family Pyralidae are the most devastating and economically important pests of combs and hive products of *Apis mellifera* L. in the world (Ellis *et al.*, 2013). The caterpillars of wax moth feed on combs, pollen, larval exuviae and other proteinaceous matter both in storage as well as in live honeybee colonies (Caron, 1999). In India, the greater wax moth infestation found throughout the year in both higher and lower altitudes (Nagaraja and Rajagopal, 2009). These were active from March to October (Sharma *et al.*, 2011, Swamy *et al.* 2009), but peak infestation was observed during July to September, generally in the brood frames and occasionally in the super frames (Gupta, 1987). There was about 90 per cent infestation in combs of *A. dorsata* colony due to attack of wax moths reported by Mahindre (1983).

Despite the fact that, only few attempts have been made to observe population dynamics of *G. mellonella* infesting honeybee (*A. mellifera* L.) combs in southern Bihar. Therefore, the present investigation was aimed to know the population dynamics of *G. mellonella* in changing environmental conditions, which may immensely be helpful for beekeepers to take care against wax moth infestation in honeybee colonies.

MATERIALS AND METHODS

Experiments were carried out at 'Beekeeping-cum-Honey Production Unit' and in the Department of Entomology, Bihar Agricultural College, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India, during dearth period from June 2015 to December 2015, located at 25°15È North Latitude, 86°57È South Longitude and an altitude of 46 meters above the mean sea level, to know the population dynamics of greater wax moth (*Galleria mellonella* L.) infesting *Apis mellifera* L. combs in changing environmental conditions.

For conduction of the experiments, three empty 4-framed beehives (without bees) were selected randomly at said unit and data on number of eggs, larvae, pupae and adults of greater wax moth present in a hive were recorded at weekly interval during dearth period of the experimentation. The observations of said parameters were recorded as given by Ellis *et al*. (2013).

The observed data were subjected to analyse the variance techniques (ANOVA) for randomized block design and to analyse the correlation of population dynamics of different stages of greater wax moth with weather parameters, the SPSS statistical software version 16.0 used.

RESULTS AND DISCUSSION

Population dynamics of different stages of greater wax moth, *G. mellonella* L. during dearth period

Number of egg clusters/ hive (having 4 frames)

The initial appearance of greater wax moth (GWM) eggs was observed (1.67 egg clusters/ hive) during 23rd standard week and recorded up to end of the December (Fig. 1). The mean number of egg clusters of GWM per hive on standard weeks of 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 and 52 were 1.67, 1.00, 2.00, 2.33, 2.67, 2.67, 2.33, 2.33, 2.67, 3.00, 2.33, 3.67, 5.67, 8.00, 9.00, 9.00, 8.67, 7.33, 3.67, 3.67, 2.33, 2.67, 3.00, 3.67, 2.67, 2.67, 2.67, 2.00, 2.33 and 2.33, respectively. The highest number of egg clusters per hive was 9.00 in the 37th and 38th standard weeks which was 5.39 times and 3.86 times more than the 23rd and 52nd standard week. There were increasing trends in number of egg clusters up to 37th standard week; afterwards it decreased slowly at weekly intervals. The highest number of egg clusters per hive was 34.67 recorded in the month of September which was 4.95 times, 3.47 times, 2.00 times, 1.76 times, 2.89 times and 3.72 times more than the June, July, August, October, November and December month, respectively. As per basis of the month wise observations on number of egg clusters presence in a hive, the peak month was September which lonely contributed about 32% out of total egg clusters observed during experimental period. The mean number of GWM eggs in different months, varied as June < July < August < September > October > November > December irrespective of the standard week and months. However, the eggs of *G. mellonella* was found to be highest from March to August, while maximum numbers of eggs was 312 observed in July from 3 colonies of *A. cerana* honeybee reported by Viraktamath (1989) in Karnataka.

Number of larvae/ hive (having 4 frames)

Likewise the eggs population, the initial population of greater wax moth (GWM) larvae was also observed (3.67 larvae/ hive) during 23rd standard week (Fig. 1). The larval population of GWM per hive was also influenced by the standard week and month wise. There were increasing trends in number of larvae of GWM 3.67, 4.00, 3.67, 4.33, 4.67, 5.67, 6.33, 5.67, 5.67, 4.67, 5.33, 6.00, 13.00, 22.33 and 26.33 during 23rd, 24th, 25th, 26th, 27th, 28th, 29th, 30th, 31st, 32nd, 33rd, 34th, 35th, 36th and 37th standard week; afterward, it decreased slowly in 38th, 39th, 40th, 41st, 42nd, 43rd, 44th, 45th, 46th, 47th, 48th, 49th, 50th, 51st and 52nd standard week with 20.67, 16.67, 13.33, 8.67, 6.33, 5.67, 4.00, 3.67, 5.00, 5.33, 4.33, 4.67, 4.00, 3.67 and 3.33, respectively, which was found in agreement with the Abrol and Kakroo (1996) observed infestation of GWM started from May onwards, which attained peak during September and declined thereafter up to January.

The highest larval population per hive was 26.33 in the 37th standard week which was 7.17 times and 7.91 times more than the 23rd and 52nd standard week. Similarly, it was reported by Varshneya *et al*. (2008) that the peak infestation of wax moth larvae was observed during 36th to 39th standard week, in entire bee hive colony having different number of brood frames. However, if we see the larval population of GWM month wise, the highest number of larvae per hive was 86.00 recorded during the month of September which was 5.49 times, 3.85 times, 2.48 times, 2.26 times, 4.69 times and 5.49 times more than the June, July, August, October, November and December month, respectively. On the other hand, in respect of larval population as well as incidence, the peak month was observed to be September which alone contributed 37.28% larval population out of total, while 6.79, 9.68, 15.03, 16.47, 7.95 and 6.79 per cent population were observed during the month of June, July, August, October, November and December, respectively. The dearth period has depleted from the month of October and the larval population of GWM also reduced by week after week. There were similar trends in respect of mean number of GWM larvae in different months, varied as June < July < August < September > October > November > December irrespective of the standard week and months. The lowest incidence of GWM larvae was 15.67 recorded in the month of June and December showed these months relatively safer against wax moth infestation in bee colony. The highest population of *G. mellonella* infesting combs of honeybee (*A. cerana*) was observed in the month of September reported by Swamy *et al*. (2005) and Varshneya *et al*. (2008). The peak infestation was observed during July to September, generally in the brood frames and occasionally in the super frames (Gupta, 1987). On an average, 46 greater wax moth larvae were recorded on individual comb and the highest number recorded on any comb was 102 in *A. mellifera*

Table 1: Correlation of weather parameters with population of different life stages of greater wax moth, *G. mellonella* L.

Weather Parameters	No. of egg clusters/ 4 frames	No. of larvae/ 4 frames	No. of pupae/ 4 frames	No. of adults/ 4 frames
Maximum Temp.	0.227*	0.292**	0.301**	0.140NS
Minimum Temp.	0.259*	0.327**	0.345**	0.252*
Maximum RH	0.065NS	-0.006NS	0.002NS	0.237*
Minimum RH	0.276**	0.322**	0.318**	0.418**
Rainfall	0.129NS	0.160NS	0.143NS	0.293**

* Significant at p < 0.05 ** Significant at p < 0.01 NS - Non Significant

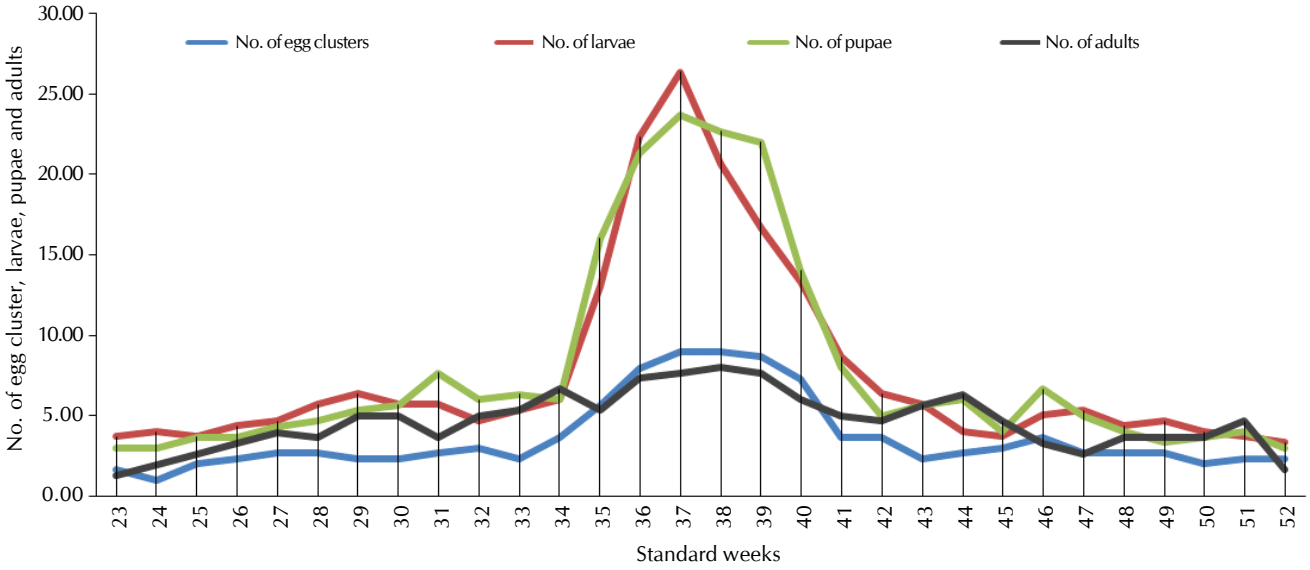
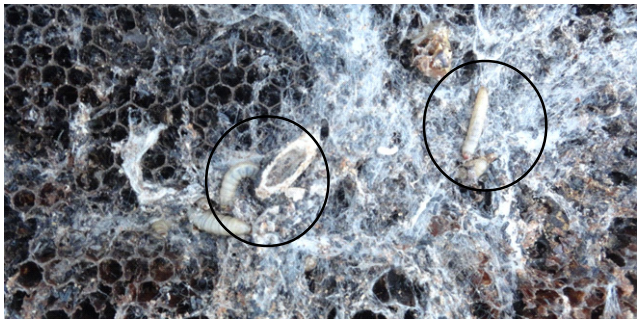
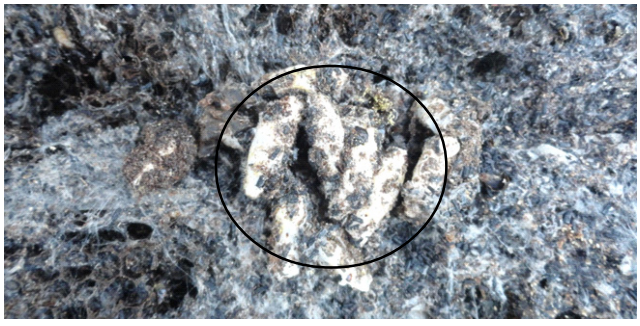


Figure 1: Population dynamics of different stages of greater wax moth (*G. mellonella*) infesting *Apis mellifera* L. combs during dearth period



***G. mellonella* larvae infesting *A. mellifera* L.**



***G. mellonella* pupae infesting *A. mellifera* L. wax comb**

***G. mellonella* adults upon infested *A. mellifera* L. comb**

colony (Singh, 2002).

Number of pupae/ hive (having 4 frames)

Likewise eggs and larval population in Fig. 1, it showed the highest population of GWM pupae per hive was 23.67 in 37th standard weeks which was 7.89 times more than the 23rd and 52nd standard week. The highest number of pupae per hive was 89.67 recorded during the month of September which was 6.72 times, 4.48 times, 2.14 times, 2.32 times, 4.56 times and 6.41 times more than the June, July, August, October, November and December month, respectively. According to overall pupal population, the month September lonely contributed 37.78% population, while 5.62, 8.43, 17.70, 16.29, 8.29 and 5.90 per cent population were attained during the month of June, July, August, October, November and December, respectively. The mean number of GWM pupae in different months, varied as June < July < August < September > October > November > December irrespective of the standard week and months both. The similar result in respect of pupal population of GWM was also reported by Viraktamath (1989).

Number of adults/ hive (having 4 frames)

Similarly the egg, larvae and pupae population, the highest population of GWM adult moths per hive was 30.67 recorded in the month of September which was 3.29 times, 1.74 times, 1.18 times, 1.11 times, 2.14 times and 2.24 times more than the June, July, August, October, November and December month, respectively (Fig. 1). However, the peak month was observed as September to attain the highest population of GWM adults which alone contributed 22.01% out of total population, whereas 6.70, 12.68, 18.66, 19.86, 10.29 and 9.81 per cent population were observed during the month of June, July, August, October, November and December, respectively. Moreover, out of seven months of observation, more than 60% adult population was recorded in the month of August, September and October. The highest infestation of honeybee combs was 59.33% during June due to attacks *G.*

mellonella reported by Ansary *et al*. (2001) in Bangladesh. Pradeepa and Bhat (2014) reported that the 92.50% colonies of honeybee were absconded due to attacks of *G. mellonella*.

Correlation of weather parameters with population of different life stages of greater wax moth, *Galleria mellonella* L.

The correlation of number of egg clusters of greater wax moth (GWM) per hive with all the weather parameters *viz*. maximum temperature (r = 0.227*), minimum temperature (r = 0.259*) and minimum relative humidity (r = 0.276**) were positively significant during dearth period, while it was non-significant with maximum relative humidity and rainfall (Table 1).

The maximum temperature (r = 0.292**), minimum temperature (r = 0.327**) and minimum relative humidity (r = 0.322**) were positive significantly correlated with the larval population of GWM per hive, whereas the negative non-significant correlation with the maximum relative humidity and positive non-significant correlation with rainfall (Table 1).

Likewise correlation of egg and larval population with weather parameters, the correlation of pupal population of GWM per hive with the maximum temperature, minimum temperature and minimum relative humidity (r = 0.301**), (r = 0.345**) and (r = 0.318**), respectively were positively significant during dearth period, while it had non-significant correlation with the maximum relative humidity and rainfall (Table 1).

The correlation of the minimum temperature (r = 0.252*), maximum relative humidity (r = 0.237*), minimum relative humidity (r= 0.418**) and rainfall (r = 0.293**) were found to be positively significant with adults population of GWM during dearth period. However, all weather parameters were positively correlated with pupal population except maximum temperature (Table 1).

The maximum number of eggs, larvae, pupae and adults of greater wax moth were observed when the maximum and minimum temperature range varied from 23-33°C and maximum and minimum relative humidity varied from 64-92% in the month of September during dearth period (Table 1). In conformity of these findings, some worker like Kumar *et al*. (2009) studied on incubation period and hatchability of eggs of *G. mellonella* (Linn.) and reported that the hatchability of eggs of *G. mellonella* was zero per cent at 40°C temperature. The incubation period was minimum at 35°C, whereas maximum at 25°C temperature. This period was found to be same at 30, 50 and 80% relative humidity. The hatching of greater wax moth eggs increased with increase in temperature and relative humidity. The adult longevity and fecundity decreased with a decrease in relative humidity and their relative humidity combination prolonged all the developmental periods and reduced the fecundity. However, 30°C temperature was found to be more favorable for all the developmental stages (Hanumanthaswamy *et al*., 2013). In agreement of the said findings Huang (1984) also agreed with the optimum temperature for larval development of *G. mellonella* and *A. grisella* was 28 -29ºC.

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