Influence of temperature and relative humidity on development of greater wax moth G*alleria mellonella* L. (Pyralidae: Lepidoptera)

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ABSTRACT

Honey bees are affected by several natural enemies. The greater wax moth (*Galleria mellonella* L.) is the most devastating pest. The influence of temperature and humidities on biology of the greater wax moth was studied in laboratory. With an increase in the temperature and relative humidity regimes there was a corresponding decrease in the total duration of greater wax moth. However, the hatching increased with increase in temperature and relative humidity. The lowest relative humidity regime (32- 33%) at 35°C and 20°C had adverse effects and the moth failed to lay eggs. At all the temperature regimes a decrease in relative humidity showed a corresponding increase in the durations of egg, larva, prepupa and pupal stage. However, the adult longevity and fecundity decreased with a decrease in relative humidity. 20°C and 25°C and their relative humidity combination prolonged all the developmental periods and reduced the fecundity. 30°C was the most favorable for all the developmental stages.

KEY WORDS: Abiotic factors, biology, *Galleria mellonella*

INTRODUCTION

The honey bee enemies create serious problems, which must be met out not only by the bee keeper but also by the bees themselves. The occurrence of such biological constraints are many and at great variance across locations and countries. In most instances, the appearance of enemy is abrupt and instantaneous which plays havoc to honey bee colonies in the apiaries. Honey bees are affected by several natural enemies. Among the natural enemies, the greater wax moth (*Galleria mellonella* L.) is the most devastating pest of honey bees. It would cause considerable damage to honey bee colonies resulting in heavy economic losses to bee keepers (Kapil and Sihag, 1983). In India it is observed infesting through the years in both higher and lower altitudes, but peak infestation is recorded during May-September. Combs of all the species of *Apis* are freely attacked by wax moths (Nagaraja and Rajagopal, 2009). During severe infestation, the combs are being found to be destroyed which cause the bee colonies to abscond. Mahindre (1983) reported about 90 per cent infestation of wax moth in the combs of *A. dorsata*. However, Brar et al. (1985) recorded 16 to 19 per cent infestation in *A. mellifera* colonies in north India. So, the present study has been taken up to assess the influence of temperature and relative humidity on biology of greater wax moth.

MATERIAL AND METHODS

The influence of temperatures and humidity on biology of the greater wax moth was studied in laboratory where both the temperature and humidity were controlled. Incubators were used to maintain constant temperatures. The humidity levels were created in desiccators, using saturated solutions of different salts (Table 1). The desiccators were in turn kept in BOD incubators, to maintain the required temperature.

Initially about one week was allowed after placing the desiccators in the incubators for the humidity levels inside the desiccators to attain equilibrium in all the temperature and humidity combinations before starting the experiment. Freshly laid eggs were held in specimen tubes (7.5 cm x 2.5 cm) and kept in desiccators of chosen relative humidities. When the eggs hatched, small piece of bee comb was provided and the additional food was added as and when the larvae consumed the initial quantity of food. Grown up caterpillars were transferred into the bigger plastic containers (0.5 lt vol.), folded paper strips were provided for pupation.

Table 1: Salts used for maintaining humidity ranges at different temperature levels

Constant Temperature	Salt	Humidity Percentage
35°C	Lead nitrate Sodium nitrate Magnesium acetate Magnesium chloride	94.5 71.0 50.5 32.5
30°C	Lead nitrate Sodium acetate Magnesium acetate Magnesium chloride	95.0 71.5 52.0 32.5
25°C	Lead nitrate Sodium acetate Magnesium nitrate Magnesium chloride	95.5 73.0 53.0 32.5
20°C	Potassium hydrogen phosphate Sodium acetate Calcium nitrate Magnesium chloride	96.5 75.0 55.5 33.0

After adult emergence, a pair of male and female moths were transferred into another plastic container (0.5 lt vol.) and folded paper strips were provided for oviposition. Observations were recorded on the duration of eggs, hatching percentage, larval, prepupal, pupal, adult male and female periods, including the pre-oviposition, oviposition, post oviposition periods and fecundity of female moths at each combination of temperature and relative humidity levels.

RESULTS AND DISCUSSION

There was a highly significant difference between the different temperatures and relative humidity regimes (Tables 2 and 3). With an increase in temperature and relative humidity there was a corresponding decrease in the duration of egg, larva, prepupa and pupa. However, the hatching percent, adult longevity, fecundity and oviposition periods showed an increase with an increase in temperature and relative humidity regimes.

A significant difference was observed between the different temperature as regards to the egg period, hatching, larval, prepupal, pupal periods, adult longevity, fecundity and oviposition period. However, temperature did not differ significantly with durations of preoviposition and post oviposition periods.

There were highly significant differences between temperature X RH interaction particularly with duration of eggs, hatching, duration of larva, prepupa, pupa, adults fecundity and ovipositional periods. However, the interaction was non significant with pre ovipositional and post ovipositional periods (Tables 2 and 3).

At 35°C, with a decrease in RH from 94.5 to 70 %, there was a corresponding increase in the duration of eggs (8.2 to 9.3 d), larva (33.60 to 45.95 d), Pre pupa (3.0 to 3.70 d), pupa (7.25 to 8.25 d), preovipositional period (1.10 to 1.30 d) and post ovipositional period (1.0 to 1.1 d). The hatching % (96.32 to 94.65 %), longevity of male (8.9 to 6.8 days), longevity of female (4.9 to 4.6 d), fecundity (eggs/female 259.90 to 109.30 and eggs/female/d, 90.64 to 49.50) and ovipositional period (2.80 to 2.20 d) showed a decrease. However, the RH 50.5 and 32.5 % were detrimental to the greater waxmoth since none of the eggs hatched (Tables 2 and 3).

As RH decreased from 95 to 13.5 % at 30°C, there was a corresponding increase in the duration of eggs (8.6 to 10.2 d), larva (45.20 to 61.50 d), Pre pupa (4.60 to 7.65 d), pupa (8.30 to 12.65 d) and preoviposition period (1.10 to 1.30 d). However, there was corresponding decrease in the hatching percentage (96.08 to 90.95%), male longevity (10.40 to 4.60 d), female longevity (from 7.60 to 4.9 d), fecundity (887.60 to 219.40 eggs/female and 163.11 to 84.44 eggs/female/d). Ovipositional period (5.40 to 2.60 d) and post ovipositional period (1.10 to 1.0 days) (Tables 2 and 3).

A similar trend of increase in duration of eggs, larval, prepupal, pupal and preoviposition period and decrease in per cent egg hatch, longevity of male and female moths, fecundity, oviposition and post – oviposition period was noticed with decrease in RH from 95 to 32.5 % at 25°C and 20°C.

However, 96.5 % and 33 % RH were detrimental to the greater waxmoth since there was no hatching eggs at 33 % RH, and in 96.5 % RH although egg hatching was recorded none of them were able to complete even the first instar (Tables 2 and 3).

This study documented that both temperature and RH regimes affect the greater wax moth. Low RH of 32 to 33 % and 20 to 25°C adversely affect the growth greater wax moth adults. Inappropriate combination of RH and temperature cause delay in growth and development of wax moth which is major natural enemies of honey bee under Shimoga conditions.

20°C and 25°C and their relative humidity combinations prolonged developmental periods and reduced the reproductive capacity. 30°C was found the most favorable. The durations of eggs, larva, pupa, prepupal periods were all completed early as compared to other lower temperatures. Moreover, the oviposition period, female longevity and fecundity were also the highest at 30°C at all the RH combinations (Cantwell and Smith, 1970).

According to Stairs (1978) larvae did not undergo significant development at 18°C and stopped at 40°C. Chauvin and Chauvin (1985) observed that at 10 % RH larvae died within 48 h, at 20 % RH mortality was high but larval life span was extended relative to that at 80 % RH. In a detailed study, Jyothi and Reddy (1994) observed that larvae at 8°C did not develop, those at 18°C remained alive upto 222 d but died without pupating. Extension of larval period from 40-60 d and pupal period from 13.9 to 18 d were reported by them when *G. mellonella* was subjected to 28°C and 38°C rearing conditions.

Table 2: Effect of interaction of temperature and relative humidity on development of Greater wax moth

Temp. (^{0} C)	R.H. (%)	Egg period (days) Mean ± sd	Hatching per cent Mean ± sd	Larval period (days) Mean ± sd	Prepupal period (days) Mean ± sd	Pupal period (days) Mean ± sd	Adult longevity	
							Male (days) Mean ± sd	Female (days) Mean ± SD
35	94.5	8.2 ± 0.42	96.32 ± 2.81	33.60 ±1.98	3.00 ± 0.92	7.25 ± 1.21	8.90 ± 1.85	4.90 ± 0.32
	71.0	9.3 ± 0.48	94.65 ± 2.46	45.95 ± 2.48	3.70 ± 0.66	8.25 ± 0.79	6.80 ± 1.87	4.60 ± 0.82
	50.5	-	0.00 ± 0.00	-	-	-	-	-
	32.5	-	0.00 ± 0.00	-	-	-	-	-
30	95.0	8.6 ± 0.52	96.08 ± 2.72	45.20 ± 5.81	4.60 ± 1.19	8.30 ± 2.08	10.40 ± 1.26	7.60 ± 0.48
	71.5	9.6 ± 0.52	95.49 ± 3.18	49.45 ± 4.29	5.10 ± 1.62	9.15 ± 0.99	9.60 ±0.70	7.30 ± 0.95
	52.0	9.8 ± 0.42	93.90 ± 0.93	50.60 ± 3.42	5.60 ± 1.60	9.60 ± 1.19	6.70 ± 3.37	6.50 ± 0.71
	32.5	10.2 ± 0.63	90.95 ± 2.92	61.50 ± 2.35	7.65 ± 1.57	12.65 ± 0.88	4.60 ± 2.37	4.90 ± 1.10
25	95.5	12.6 ± 0.52	95.68 ± 3.96	-	-	-	-	-
	73.0	13.3 ± 0.48	94.12 ± 4.03	63.15 ± 4.03	5.80 ± 0.77	11.20 ± 2.46	13.50 ± 4.50	6.70 ± 1.64
	53.0	13.6 ± 0.52	93.57 ± 3.64	73.30 ± 3.77	9.75 ± 1.62	13.35 ± 0.67	12.90 ± 4.31	5.20 ± 0.67
	32.5	14.0 ± 0.00	42.35 ± 18.42	80.15 ± 1.66	12.30 ± 2.52	16.50 ± 2.84	8.00 ± 3.27	2.80 ± 0.52
20	96.5	23.2 ± 1.32	90.96 ± 2.97	-	-	-	-	-
	75.0	24.7 ± 0.48	89.27 ± 3.52	87.90 ± 6.79	7.15 ± 0.88	13.05 ± 1.93	12.60 ± 3.31	6.00 ± 1.33
	55.5	27.2 ± 1.03	83.65 ± 11.56	123.95 ± 8.95	10.55 ± 0.94	17.65 ± 0.93	10.00 ± 1.05	3.90 ± 0.42
	33.0	-	0.00 ± 0.00	-	-	-	-	-
CV (%)		4.51	8.33	7.17	20.465	14.0	29.83	16.25
F		1041.98**	400.98**	598.83**	90.05**	90.39**	10.05**	38.58**
Prob.		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
CD at 0.05%		0.56	5.28	4.08	0.87	1.00	2.47	0.79

*: Significant at $P < 0.05$ **: Significant at $P < 0.01$

Table 3: Effect of interaction of temperature and relative humidity on the biological parameters of Greater waxmoth

Temp.	R.H. (%)	Fecundity (Eggs / F) Mean ± sd	Fecundity (Eggs/F/Day) Mean ± sd	Pre-ovi. Period (days) Mean ± sd	Ovi. Period (days) Mean ± sd	Post-ovi. Period (days) Mean ± sd
35°C	94.5	259.90 ± 193.70	90.64 ± 42.81	1.10 ± 0.74	2.80 ± 1.55	1.00 ± 0.67
	71.0	109.30 ± 56.78	49.50 ± 29.03	1.30 ± 0.95	2.20 ± 0.82	1.10 ± 0.74
	50.5	-	-	-	-	-
	32.5	-	-	-	-	-
30°C	95.0	887.60 ± 79.62	163.11 ±27.35	1.10 ± 0.32	5.40 ± 0.71	1.10 ± 0.32
	71.5	549.90 ± 113.53	107.36 ± 37.17	1.10 ± 0.32	5.10 ± 0.57	1.10 ± 0.32
	52.0	389.70 ± 179.18	89.10 ± 27.63	1.20 ± 0.42	4.30 ± 1.06	1.00 ± 0.00
	32.5	219.40 ± 118.64	84.44 ± 41.02	1.30 ± 0.48	2.60 ± 0.70	1.00 ± 0.00
25°C	95.5	-	-	-	-	-
	73.0	269.50 ± 70.55	62.74 ± 29.61	1.20 ± 0.42	4.20 ± 0.92	1.30 ± 0.48
	53.0	168.80 ± 122.86	53.77 ± 58.45	0.90 ± 0.74	3.10 ± 2.42	1.00 ± 0.82
	32.5	27.90 ± 56.42	22.72 ± 35.30	0.70 ± 1.06	1.10 ± 1.52	0.80 ± 1.03
20°C	96.5	-	-	-	-	-
	75.0	32.20 ± 39.48	8.89 ± 7.90	1.40 ± 0.70	3.60 ± 1.51	1.00 ± 0.47
	55.5	8.60 ± 7.76	5.04 ± 6.15	1.40 ± 1.17	1.70 ± 1.25	0.70 ± 0.48
	33.0	-	-		-	-
CV (%)		40.43	58.79	62.71	38.13	56.78
F		59.68**	13.25**	0.85 NS	16.19**	0.76 NS
Prob.		0.0001	0.0001	-	0.0001	-
CD at 0.05%		95.66	31.12	-	1.13	-

* : Significant at P < 0.05 **: significant at P < 0.01 NS : Non – significant

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