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BIOLOGY AND BIONOMICS OF *DYSDERCUS KOENIGII* F. (HEMIPTERA: PYRRHOCORIDAE) UNDER LABORATORY CONDITIONS

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Red Cotton Bug, *Dysdercus koenigii* F., (Hemiptera: Pyrrhocoridae) is an important pest of cotton in South East Asia. Studies were carried out during 2012 to find the effect of temperature on incubation period and to explore the reproductive biology and bionomics of *D. koenigii* under laboratory conditions. Minimum incubation period (4.70±0.42 days) was recorded at 35°C while the eggs failed to hatch at 40°C at 70-75% relative humidity. There were five nymphal instars which completed their development in 23.42±2.49 days. The female lived longer (20.85±6.12 days) than the male (16.18±6.06 days). Each female mated three times in her life and there was statistically significant difference in mating duration (days), number of eggs laid and hatching percentage in each mating time. Number of eggs and hatching percentage was significantly higher after 1st time mating followed by 2nd and 3rd time matings. Duration of pre-oviposition, oviposition and post oviposition period recorded was 7.47±0.86, 12.43±0.82 and 8.77±2.41 days, respectively. The study will help in devising pest management strategy against *D. koenigii*.

***Keywords*:** Bionomics, *Dysdercus koenigii*, reproductive biology, cottonseeds

INTRODUCTION

Bacillus thuringiensis inserted transgenic cotton (BT) has been cultivated in Sub-continent (Dhillon, 2011) and research has also proved that bollworms, i.e. *Helicoverpa armigera, Pectinophora gossypiella, Earias insulana and Earias vitella* are not a major problem in BT cotton. However, severity in infestation of army worm, *Spodoptera litura, S. exigua,* and sucking complex, i.e. *Amrasca devastans, Bemisia tabaci* and *Thrips tabaci* are observed in the whole Pakistan (Ashfaq *et al*., 2011). In year 2011, there was severe lint staining problem and decrease in market price followed by conversation on causes of cotton staining. It is thought that major cause of cotton staining is red cotton bug, *D. koenigii* (Anonymous, 2013).

Red cotton bug, *Dysdercus koenigii* F. (Heteroptera: Pyrrhocoridae) is the destructive pest of cotton due to severe lint staining problem (Ahmad and Mohammad 1983; Ashfaq *et al*., 2011). *Dysdercus* spp. feed on emerging cotton bolls and mature cotton seeds, and transmits cotton staining fungi, *Nematospora gossypii* that develops on the immature lint and seed (Maxwell-Lefroy, 1908; Freeman, 1947; Van Doesburg, 1968; Fuseini and Kumar, 1975; Iwata, 1975; Ahmad and Kahn, 1980; Ahmad and Schaefer, 1987; Yasuda, 1992). Alternate hosts of *D. koenigii* include okra, hollyhock (Kamble, 1971) and plants of family Bombacaceae (Kohno and Ngan, 2004).

Red cotton bug (*Dysdercus koenigii* Fb.) is an important insect pest, which reproduces rapidly in the field, so it has fast and efficient egg development (Venugopal *et al*., 1994) thus they are difficult to control only with insecticides. In order to develop an effective pest management system for *D. koenigii*, the studies on life cycle, reproductive biology and bionomic of the pest are necessary. The information on these aspects of *D. koenigii* in Pakistan is very little. Despite of the fact that some work on the bionomics and life cycle of *D. koenigii* in India has been reported (Kamble, 1971; Varma, 2012), but information regarding life cycle, reproductive biology and bionomics of *D. koenigii* is in-sufficient according to environmental conditions of Pakistan. Current study was planned to study life cycle, reproductive biology and bionomics of *D. koenigii* for devising integrated pest management strategies for *D. koenigii* problem.

MATERIALS AND METHODS

Collection and rearing of *D. koenigii*: The adults of *D. koenigii* were collected from cotton field of Bahauddin Zakariya University, Multan, Pakistan during February, 2012. Rearing was done under laboratory conditions (28±2ºC, 70-75% RH, 11L: 13D photoperiod) in plastic chamber (4×4 inches) on soaked fuzzy cottonseeds (MNH 886). The plastic chambers were half filled with sterilized soil as natural medium for oviposition. Cotton seeds were replaced every day from plastic chamber (Kamble, 1971; Kohno and Ngan, 2004). Filter paper was placed on the soil to maintain moderate moisture level in the plastic chamber. Filter paper was also changed on daily basis.

***Effect of temperature on incubation period of D. koenigii*:** Incubation period was measured at four different

temperatures, i.e. 25ºC, 30ºC, 35ºC and 40ºC in incubator (Model VELP #FTC 90E, Japan). For this purpose, a total of 500 eggs in 10 replications were used for each temperature gradient. The desired temperature was maintained in the incubator. The eggs were daily observed with hand lens for hatching.

Life cycle, reproductive biology and bionomics of *D. koenigii*: To study the reproductive biology of *D. koenigii*, thirty pairs (30 males and 30 females) were selected from the collection and placed in plastic chambers separately for copulation and oviposition. The eggs laid down by each pair were counted with fine needle. The duration of each stage of *D. koenigii* was studied by placing 60 newly hatched nymphs separately in plastic chambers. Nymphal duration, adult longevity of both male and female, pre-oviposition, oviposition and post-oviposition period were recorded. Mating duration, number of matings, number of eggs laid with respect to mating time, hatching period, and numbers of nymphs were also recorded by observing either with eyes or where necessary with a simple microscope.

For studying bionomics, five individuals in each instar were randomly selected and length, width of body, antennal size, proboscis length, length of fore leg, length of hind leg and forewing length were measured. Measurements were done using stage micrometer (0.01-1mm) ocular (0.2-2.5mm) and graded scales (1-150mm).

***Statistical analysis*:** Statistical analysis was done by using MSTAT-C software (Steel and Torrie, 1980) and the means were separated by Least Significant Difference (LSD) at P=0.05 for analysis after each experiment related to hatching time of eggs on different incubation temperature, effects of light and darkness on incubation period, duration of each life stages, different stages of oviposition, difference between consecutive eggs layings duration, mating duration at different times, number of eggs laid and its hatching percentage and bionomics of each stages of *D. koenigii* was done.

RESULTS AND DISCUSSION

***Incubation Period*:** Color of eggs was creamy white which turns to yellowish orange before hatching. There was statistically significant difference in incubation time of *D. Koenigii* eggs at varying temperatures (P<0.0001, F=110.14, DF=18, n=10). Results of Fig. 1 show negative correlation of temperature and incubation time. It was found that incubation time prolonged from 4.70±0.42 at 35ºC to 6.70±0.63 at 30ºC and 9±0.82 days at 25ºC, whereas fatal for development of *D. koenigii* was found at 40ºC. Data observed under light and dark condition of treatments showed that it took 6.70±0.48 and 5.65±0.88 days for incubation respectively. Hatching efficiency was not affected by photoperiod (Fig. 2).

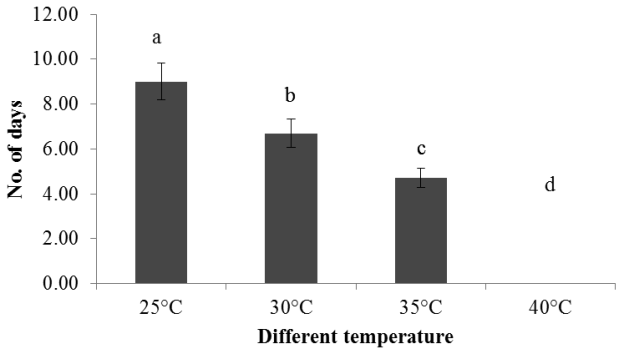

Figure 1. Effect of different temperatures on incubation period of *Dysdercus koenigii*. Mean values followed by a common letter do not differ statistically (P≤0.05)

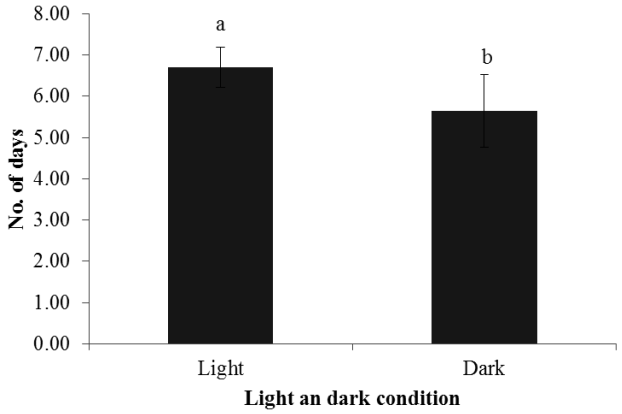

Figure 2. Response of light and dark conditions on incubation period of *Dysdercus koenigii*. Mean values followed by a common letter do not differ statistically (P≤0.05)

***Nymphs*:** Five nymphal instars were observed in *D. koenigii.* Duration and bionomics of each stage is described as under:

***First instar*:** Color of newly emerged nymphs was light orange which turns to blood red within one day. Duration of first instar lasted for 2.77±0.37 days (Fig. 3). Body length of the first instars nymph was measured 1.58±0.11 mm and width 0.94±0.20 mm. The antennal length were shorter than the body and measured 1.00±0.13 mm, foreleg 1.33±0.02 mm, hind leg 1.37±0.04 mm and proboscis 0.76±0.11 mm. Wing pads were absent in first instar (Table 1).

***Second instar*:** Second instar was similar in appearance to that of first instar but was larger in size. Duration of second instar lasted for 3.84±0.37 days (Fig. 3). The second instar nymph was measured 3.02±0.20 mm in length and 1.25±0.04 mm in width. The length of the antennae, foreleg, hind leg and proboscis was 2.31±0.07 mm, 1.89±0.04 mm, 3.82±0.42 mm and 2.56±0.09 mm, respectively (Table 1).

Table 1. Bionomics of *Dysdercus koenigii* (n=5) in relation to different stages

Insect stages	Size of different body parts (mm) ± S.E.**						
	Body length	**Body width**	**Fore leg Length**	**Hind leg length**	**Antennal length**	**Proboscis length**	**Forewing length**
1st instar	1.58 ± 0.11 g	0.94 ± 0.20 g	1.33 ± 0.02 g	1.37 ± 0.04 g	1.00 ± 0.13 g	0.76 ± 0.11 g	Absent
2nd instar	3.02 ± 0.20 f	1.25 ± 0.04 f	1.89 ± 0.04 f	3.82 ± 0.42 f	2.31 ± 0.07 f	2.56 ± 0.09 f	Absent
3rd instar	5.52 ± 1.25 e	2.36 ± 0.89 e	4.01 ± 0.87 e	5.37 ± 1.30 e	4.09 ± 1.14 e	3.66 ± 0.51 e	Absent
4th instar	9.06 ± 1.34 d	3.64 ± 0.34 d	6.42 ± 0.16 d	8.00 ± 0.58 d	6.27 ± 0.18 d	4.93 ± 0.18 d	Absent
5th instar	12.22 ± 0.20 c	4.98 ± 0.13 c	8.10 ± 0.1 6 c	11.21 ± 0.16 c	8.33 ± 0.18 c	6.01 ± 0.11 c	Absent
Male	14.00 ± 0.16 b	7.32 ± 0.49 b	10.62 ± 0.65 b	14.48 ± 0.20 b	9.34 ± 0.27 b	7.00 ± 0.16 b	10.04 ± 0.69b
Female	15.30 ± 0.11 a	8.44 ± 0.29 a	12.16 ± 0.16 a	15.14 ± 0.11 a	10.04 ± 0.11 a	7.28 ± 0.16 a	11.22± 0.22a
LSD	0.85	0.57	0.58	0.74	0.58	0.29	0.19
F value	347.14	225.61	445.12	443.11	310.31	575.96	56.40

*Mean values followed by the different letter in the same column are statistically different ($P \leq 0.05$)
** S.E. = Standard Error

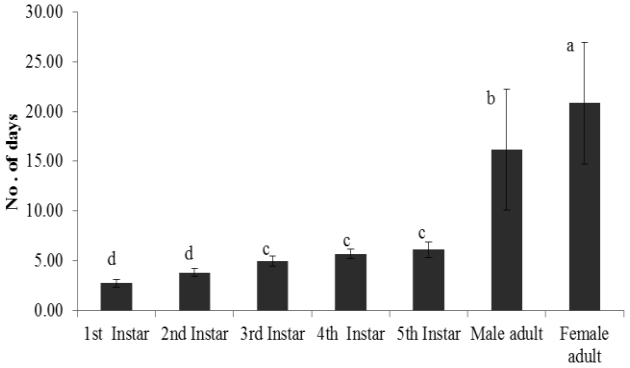

Figure 3. Life Duration of each stage of *Dysdercus koenigii* under laboratory condition (28±2 ºC, 70-75% Relative humidity)

***Third instar*:** Third instar was different from first and second instar because of emergence of wing pad on thorax. Initially moulted nymphs were orange red in color which changed to reddish color within one day. Three pairs of unclear dorsal spots were developed on the abdomen. While the duration of third instar completed in 4.98±0.51 days (Fig. 3). Length of third instar was measured 5.52±1.25 mm, width 2.36±0.89 mm. The length of antenna, foreleg, hind leg and proboscis was 4.09±1.14 mm, 4.01±0.87 mm, 5.37±1.30 mm and 3.66±0.51 mm respectively (Table 1).

***Fourth instar*:** Fourth instar was tubular in shape and crimson red in color. Wing pad developed up to posterior margin of metathorax. Posterior tips of wing pad darker in color than proximal part. White transverse band appear on the 3rd abdominal to 7th abdominal segments. Duration of fourth instar lasted for 5.71±0.47 days. Fourth instar was measured 9.06±1.34 mm in length and 3.64±0.34 mm in width. The antennal, foreleg, hind leg and proboscis lengths were 6.27±0.18 mm, 6.42±0.16 mm, 8.00±0.58 mm and 4.93±0.18 mm respectively (Table 1).

***Fifth instar*:** Fifth instar was also in cylindrical in shape and crimson red in color. Prominent wing pads appeared. Proboscis remained crimson red in color while antennae and legs were black in color. Antennae were five segmented. Duration of fifth instar was completed in 6.12±0.77 days (Fig. 3). The average size of body was 12.22±0.20 mm in length and 4.98±0.13 mm in width. The antenna measured 8.33±0.18 mm whiles the length of foreleg, hind leg and proboscis was 8.10±0.16 mm, 11.21±0.16 mm and 6.01±0.11 mm respectively (Table 1).

***Adults*:** Adults of *D. koenigii* were also crimson red in color. Hind wings were membranous and broader than fore wings. Hind wings remained concealed under fore wings at rest. Fore wings have black spot in center. Duration of male adult lasted for 16.18±6.06 days while that of female adult lasted for 20.85±6.12 days (Fig. 3). The female was larger than the male and measured 15.30±0.11 mm length and 8.44±0.29 mm width as compared to male with 14.00±0.16 mm length and 7.32±0.49 mm width. Antennal length of female adult measured 10.04±0.11 mm, while that of male adult measured 9.34±0.27 mm. Foreleg of female and male adult were 12.16±0.16 mm and 10.62±0.65 mm respectively. Hind leg of female adult was 15.14±0.11 mm while male adult was 14.48±0.20 mm. Length of proboscis of female and male was 7.28±0.16 mm and 7.00±0.16 mm respectively. Fore wings in female was measured 11.22±0.22 mm, while in male they measured 10.04±0.69 mm.

***Adult longevity*:** Data of life duration showed that male and female they lived for 27.5-56 and 32.5- 61.5 days respectively at 28±2ºC when adequate food (soaked cottonseeds) was given.

***Mating*:** Pre-mating period lasted for 3.5±0.62 days and males and females of this species mated three times in their life span followed by oviposition after each mating. However, duration of each mating lasted for 1-3.5 days ($P<0.0001$, $F=9.01$, $DF=58$) (Fig. 4).

***Oviposition period*:** Pre-oviposition period was found to be 7.47±0.86 days depending upon the vigor and ovary development. The oviposition period, 1st to 3rd egg laying, remained for 12.43±0.82 days (Fig. 5). Difference in 1st and

2nd; 2nd and 3rd; 1st and 3rd eggs laying was 6.32±0.43, 3.63±0.69 and 9.95±0.81 days respectively (Fig. 6). Post-oviposition period remained 8.77±2.41 days (P<0.05, F=74.39, DF=58, n=30) (Fig. 5).

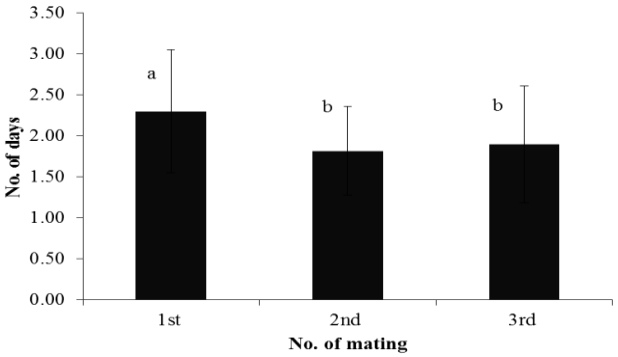

Figure 4. Mating duration of *Dysdercus koenigii* at different times. First time mating duration was significantly higher than the 2nd and 3rd time mating duration (P≤0.05)

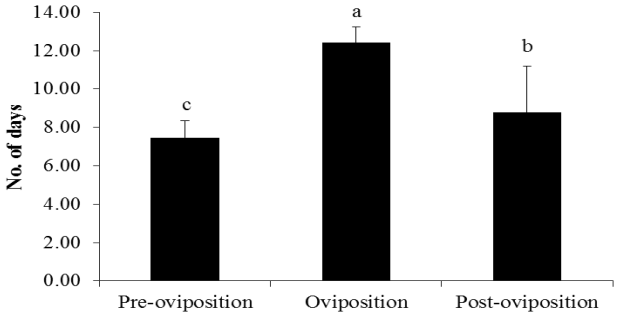

Figure 5. Duration of pre-oviposition, oviposition and post-oviposition of *Dysdercus koenigii*. Mean values followed by a common letter do not differ statistically (P≤0.05)

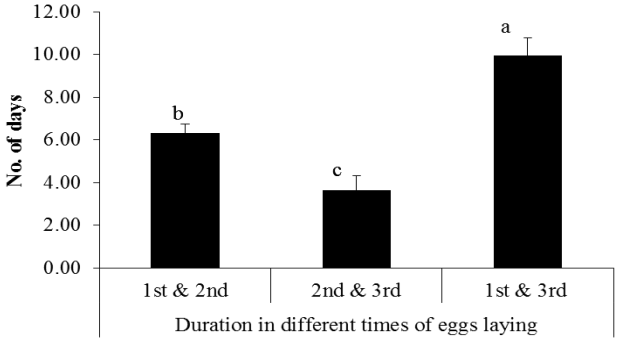

Figure 6. Difference between consecutive oviposition periods of *Dysdercus koenigii*. Mean values followed by a common letter do not differ statistically (P≤0.05)

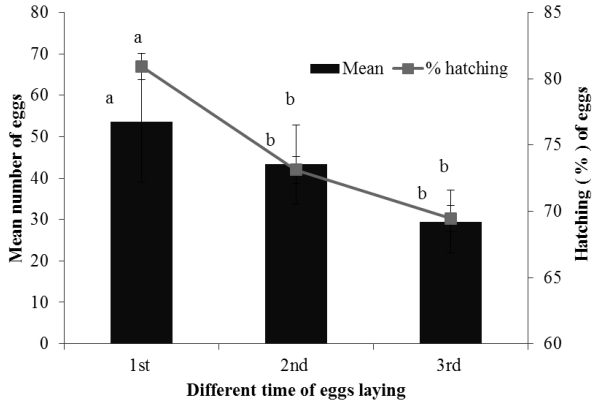

Figure 7. No of Eggs harvested after different times mating & eggs hatching percentage of *Dysdercus Koenigii*. Lower case showed mean number of eggs first time number of eggs significantly higher than the second and third time eggs laying, while upper case showed hatching percentage of eggs of *Dysdercus koenigii* first time hatching percentage significantly higher than the second and third times of eggs laying (P≤0.05)

***Fecundity*:** There was statistically significant difference in egg laying by same female at different times (P<0.05, F=1364.43, DF=58, n=30). There was significant difference in number of eggs laid by each female in her life span (P<0.05, F=83.42, d= 58, n=30). The number of eggs varied from 39-183 during 1st to 3rd times. Fig. 7 shows that there were 53.63±14.55, 43.31±9.54 and 29.50±7.52 eggs in 1st, 2nd and 3rd batch, respectively and there was statistically significant difference between number of eggs laid first as compared to second and third egg laying (P<0.0001, F=70.68, DF=58, n=30). Data of hatching efficiency of each batch was also recorded and it was found that hatching efficiency was 80.93±6.97, 73.11±3.94 and 69.45±3.92% of first second and third time eggs laying, respectively. So hatching efficiency of first time of eggs laying was significantly different from second and third time eggs laying (P<0.0001, F=15.74, DF=58, n=30), while there was non-significant difference between second and third time hatching efficiency of eggs. There was 1:1 female: male ratio in the population.

In the current study, we measured the body length and width, and the length of antenna, proboscis, fore leg and hind leg of life stages of *D. koenigii* on soaked cotton seeds. Our results for life duration and bionomics of *D. koenigii* were higher from previous work of Kamble (1971) who studied the life cycle and bionomic of this pest on okra fruits. The change in feed could cause changes in the life cycle, biology (Fig. 8), vigor and other parameters of the *D. koenigii* (Lot, 1956; Kohno and Ngan, 2004; Kohno and

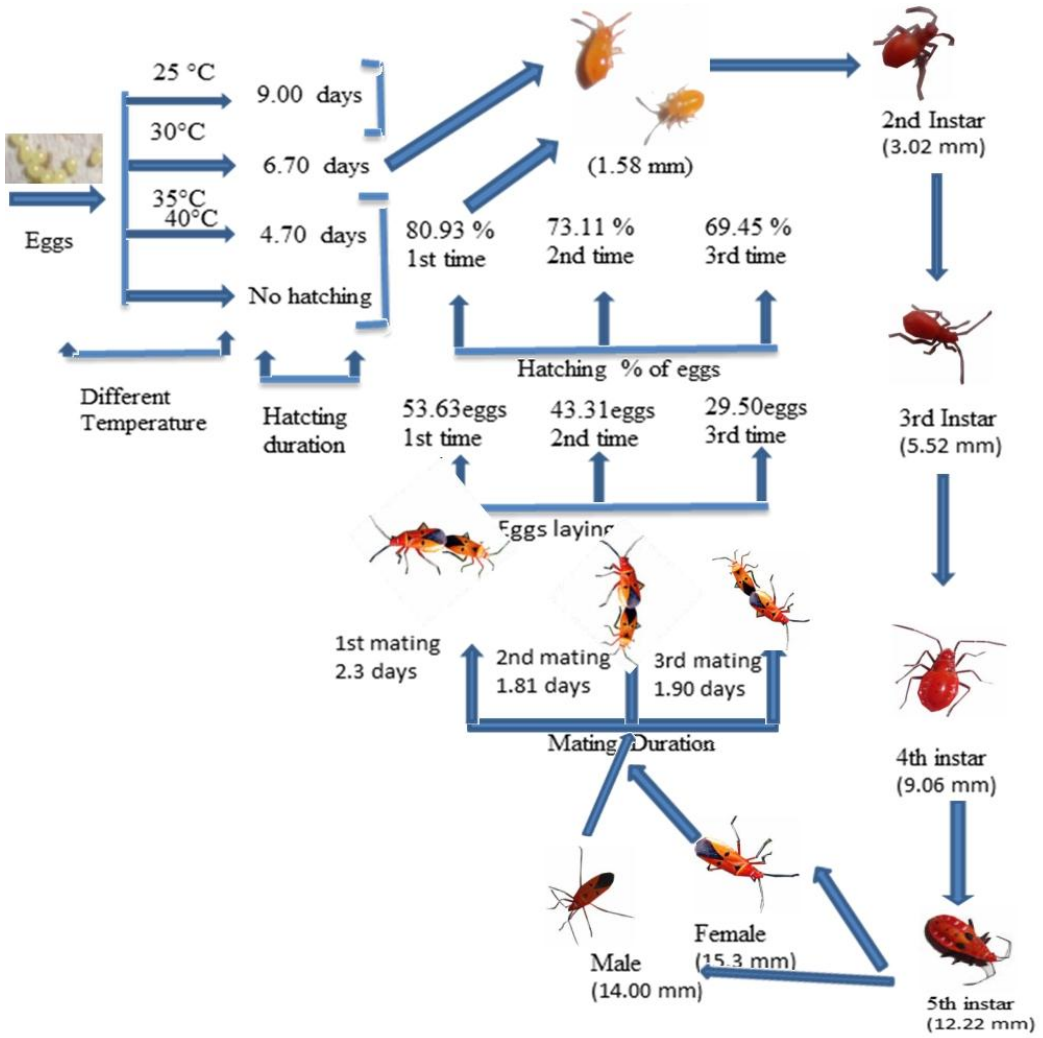

Figure 8. Pictorial representation of reproductive biology, bionomics of *Dysdercus koenigii* (Hemiptera: Pyrrhocoridae) and response of incubation period to different temperatures

Ngan, 2005; Socha, 2008). The change of temperature could also alter the duration and other parameters of an insect (Schlichting and Pigliucci, 1998). Kamble (1971) and, Varma and Patel (2012) studied the biology and bionomics of this pest at 24±7.76°C while we studied these parameters at controlled temperature (28±2°C). This temperature change might be responsible for higher results of life duration and bionomics of *D. koenigii* from the previous work of Kamble (1971) and Varma and Patel (2012) in the current study. The present study could be helpful to develop IPM strategies against *D. koenigii.*

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