RATE OF DEVELOPMENT AND REPRODUCTIVE POTENTIAL OF THE BLACK MELON BUG, *CORIDIUS (ASPONGOPUS) VIDUATUS* F. (HEMIPTERA: PENTATOMIDAE) IN RELATION TO CONSTANT TEMPERATURES

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ABSTRACT

The effects of constant temperatures of 24, 28 and 32°C on the rate of development and survival of different stages of the black melon bug (BMB), *C. viduatus* as well as on the reproductive potential of the adult were studied. The data indicate that the longest time required for the insect to complete its life cycle (81.59 days) was recorded at 24°C, whereas the shortest period (34.45 days) was recorded at 32°C. The mortality rates were 57.31%, 64.67% and 70.14% at 24, 28 and 32°C, respectively. The calculated developmental threshold from egg to adult emergence of the pest was about 18.15°C. By using this value as a base temperature, an average of about 439.03 day-degrees was calculated for the pest to complete its life cycle. The oviposition period was 121.7, 118.7 and 73.50 days at 24, 28 and 32°C, respectively. The highest number of eggs (462.05 eggs/female) was obtained at 28°C, the lowest number (23.10 eggs/female) was recorded at 24°C. The duration of one generation (GT) of the pest lasted about 206.96, 129.02 and 87.54 days; the population of the pest had the capacity to double (DT) every 105.02, 23.18 and 14.87 days; the reproductive rates (R_0) were about 3.97, 47.95 and 59.59 times within a single generation; the values of the intrinsic rate of increase (rm) were 0.0066, 0.0299 and 0.0466, and the population of the pest had a capacity to multiply (λ) about 1.0066, 1.0304 and 1.0478 times per female per day at 24, 28 and 32°C, respectively. The calculated biological parameters indicated that temperatures of 32°C seem to be the most favorable thermal zone for the development and reproduction of this pest.

INTRODUCTION

Black melon bug (BMB), *Coridius (Aspongopus) viduatus* F. is a serious pest in the New Valley that mainly attacks cucurbit plants. Despite the importance of this pest, quantitative data describing its life history over a range of environmental

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conditions at which it will develop are lacking. Such data can be use to develop simulation models for optimizing pest management strategies. According the available literature, scarce information were found concerning the biology of *C. viduatus*. Sharma (1990) mentioned that, the female of the *Aspangopus* spp. lays eggs one by one in a row on the lower surface of the leaf, stem, and other parts of the host plant. Ben-Yakir *et al.* (1996) found that, *C. viduatus* was reared indoors at 24 ± 2°C on squirting cucumber and took 5-6 weeks to develop from egg to adult. Each pair of bugs gave rise up to 470 new adults over a period of 5 months. The present investigation was conducted to study some biological parameters of the BMB under constant temperatures and to estimate the construction of its life-fecundity table.

MATERIAL AND METHODS

A cultural of the BMB, *C. viduatus* was started using adults collected from watermelon field cultivated in the experimental farm of the New Valley Station, El-Kharga, New Valley. The culture was maintained under laboratory conditions on watermelon leaves in wooden cage (50x40x40 cm). Watermelon leaves were supplied to serve as diet and oviposition substrate.

The effects of constant temperatures of 24, 28 and 32°C on the development of the immature stages and reproductive potential of adults were studied.

1. Egg stage

About 1000 eggs (<24 hrs. old) in ten replicated were incubated in each temperature regime and examined daily. The number of hatched eggs was recorded and the incubation periods were calculated.

2. Nymphal stage

Newly emerged nymphs were placed separately in watermelon leaves into glass containers (6x30 cm). The upper rim of the container was covered with mesh screen and fixed with rubber bands. About 100 nymphs were reared and each temperature regime. The nymphs were observed daily to determine moult, mortality and replace the watermelon leaves. Development threshold was calculated according to Karl (1968) and the thermal units (TU in day-degrees) according to Madubunyi and Kochler (1974).

3. Adult stage

The immature stages of the pest were allowed to develop in each temperature regime to reach adult stage. Pairs of newly emerged female and male each were confined separately in a glass cage (6x30 cm). About 50 pairs were reared in each temperature regime and fed on plant parts of watermelon. The cages were examined daily and the deposited eggs were removed and counted. The procedure was continued until the adult dead. The obtained data were used to calculate the oviposition periods, net reproduction rate (R_0), Generation time (GT), doubling time (DT), intrinsic (rm) and finite (λ) rates of increase according to Birch (1948). Data were analyzed using analysis of variance and means were compared according to the least significant difference (LSD).

RESULTS AND DISCUSSION

1. Effect of constant temperatures on the immature stages

1.1. Egg stage

Data in Table 1 show the incubation periods and the hatchability of the eggs of the BMB as affected by temperature. There were significant differences between the incubation periods at different constant temperatures. The highest period (14.90 days) was recorded at 24°C and the shortest one (7.32 days) at 32°C. The highest percentage of unhatched eggs (45.00%) was recorded at 32°C, meanwhile, the lowest rate (22.90%) at 28°C.

Data in Table 1 were used to calculate the developmental threshold (to) of the eggs. It was about 16.32°C. By using this value as a base temperature, an average of 111.73±5.82 day-degrees was calculated for the development of this stage.

TABLE (I)

Duration (in days) and mortality (%) of the immature stages of the BMB at different constant temperatures.

Temp. (°C)	The immature stages					
	Egg		Nymph		From egg to adult	
	Duration	Morality	Duration	Morality	Duration	Morality
24	14.91 A ±1.29	23.80	66.68 A ±4.16	33.51	81.59 A ±4.16	57.31
28	8.96 B ±0.68	22.90	33.95 B ±2.45	41.77	42.91 B ±2.39	64.67
32	7.32 C ±0.61	45.00	27.13 C ±1.49	25.14	34.45 ±1.43	70.14

Means within a column followed by the same litter are not significantly different at 0.05 level of probability

1.2. Nymphal stage

As shown in Table 1, significant differences were found between the durations of nymphal stage at different constant temperatures. Raising temperature from 24°C to 28°C shortened the developmental period of the nymph by about 33 days, whereas a decrease of only 7 days was found when temperature raized from 28°C to 32°C. The highest mortality percentage of the nymphal stage (41.17%) was recorded at 28°C, whereas the lowest rate (25.14%) at 32°C (Table 1). As shown in Table 2, the calculated developmental threshold of the nymphal stage was estimated as 18.15°C. By using this value as base temperature an average of 351.41±25.31 day-degrees was found to be need for the development of this stage.

1.3. From egg to adult

Data in Table 1 show the developmental periods of the pest from egg to adult at different constant temperatures. The longest period required for the pest to complete its life cycle (81.59±4.16 days) was recorded at 24°C, whereas shortest one (34.45±1.43 days) at 32°C. The mortality rates increased from 37.31% at 24°C to 70.14% at 32°C. The calculated developmental threshold (t0_ was about 18.15°C. An average of 439.03±31.49 day-degrees was needed for the pest to complete its life cycle (using 18.10°C as a base temperature) (Table 2).

TABLE (II)

Developmental threshold (to) and thermal units (TU) (in day-degrees) needed for the development of different stages of BMB at different constant temperature.

Stages	Tem. Threshold (to°C)	Thermal units (day-degrees)				
		Temperature			Total	Mean ±SD
		24	28	32		
Egg	16.28	115.1	105.01	115.07	335.19	111.73 ±5.82
Nymph	18.51	366.07	322.15	365.98	1054.24	351.41 ±25.31
From egg to adult	18.15	477.30	422.66	477.19	1377.09	459.03 ±31.49

2. Effect of constant temperatures on the adult stage

2.1. Longevity and fecundity

Data presented in Table 3 show the average of the pre-, oviposition and post-ovipositon periods of the BMB at the tested temperatures. Significant differences were found between the oviposition periods at the different constant temperatures.

The longevity of the female ranged from 258.40±76.35 days at 24°C to 97.85±44.58 days at 32°C. The females, generally, lived longer than the males under all tested temperatures. Regardless of temperature, the pre-oviposition period needed 21.87% of the longevity; the oviposition period required 61.98%, whereas the post-oviposition period needed 16.15% from the whole longevity. Data in Table 3 also show that the highest number of the deposited eggs (464.80±330.81 eggs/♀) was recorded at 28°C, followed by those deposited at 32°C (405.45±228.88 eggs/♀).

TABLE (III)

Longevity and fecundity of the BMB at different constant temperatures.

Temp. (°C)	Duration (in days) ± SD					Eggs ± SD
	Oviposition period			Longevity		
	Pre-	Ovi-	Post-	Female	Male	
24	70.10 A ±29.90	121.70 A ±95.14	66.60 A ±60.24	258.40 A ±76.35	210.35 A ±70.91	23.10 B ±20.53
28	23.85 B ±11.14	118.70 AB ±64.95	7.65 B ±8.45	150.20 B ±59.23	141.95 B ±52.31	464.80 A ±330.81
32	16.80 B ±3.47	73.50 B ±42.45	7.55 C ±8.86	97.85 C ±44.58	70.55 C ±36.22	405.45 A ±228.88
Mean ±SE	36.92 ±16.47	104.63 ±15.61	27.27 ±19.69	168.82 ±47.33	140.95 ±40.41	

Means within a column followed by the same litter are not significantly different at 0.05 level of probability

2.2. Certain life table parameters

The calculated biological parameters of the BMB reared at different constant temperatures [Generation time (GT), Doubling time (DT), Net reproductive rate (R_0) and the rates of increase (rm & λ)] are presented in Table 4. The duration of one generation lasted about 206.96, 129.02 and 87.54 days at 24, 28 and 32°C, respectively. The duration of a generation at 24°C was about 1.6 and 2.4 times as long as at 28 and 32°C, respectively. The population of this pest had the capacity to double (DT) every 105.02, 23.18, 14.87 days. This pest can increase (R_0) about 3.97, 47.95 and 59.59 times within a single generation at 24, 28 and 32°C, respectively. The highest value of rm (0.0466 at 32°C) was nearly 7 and 1.56 times higher than those of the pest at 24 and 28°C, respectively. On the other hand, when the values of (rm) were converted to the finite rate of increase (λ), the population of the BMB had a capacity to multiply about 1.0066, 1.0304 and 1.0478 times per female per day at 24, 28 and 32°C, respectively.

TABLE (IV)

Certain life tale parameters of the BMB reared at different constant temperatures.

Temp. (°C)	Gen. time (in days)	Doubling time (days)	Net rep. rate (R_0)	Rate of increase	
				Intrinsic (rm)	Finite (λ)
24	206.96	105.02	3.97	0.0066	1.0066
28	129.02	23.18	47.95	0.0299	1.0304
32	87.54	14.87	59.59	0.0466	1.0478

This study has shown that temperature of 28°C was the most suitable condition for egg hatching and duration. A developmental threshold (to) of 16°C and an average of 111.73±5.82 day-degrees were calculated for the development of the egg stage. Nearly the same trend was recoded by Mohamed, 1977 and Ali *et al.*, 1983, who found that, the longest incubation period of *Nezara viridula* eggs was recorded at 20°C, meanwhile, the shortest one observed at 30°C. High temperature was found to be the optimum for the egg development of other Heteropteran eggs (El-Shazly, 1994 and El-Sebay *et al.*, 2002). A developmental threshold (to) of 16°C and an average of 111.73±5.82 day-degrees were calculated for the development of the egg stage.

The obtained data revealed that the duration of the nymphal stage of the BMB is generally affected by temperature. The calculated developmental threshold of the nymphal stage was about 18.15°C and the thermal units needed for its development was about 351.41±25.31 day-degrees. The results of the present investigation are in general agreement with Gutierrez *et al.*, 1991 and Clercq and Degheele, 1992, who suggested that the pentatomid species were better adapted to high temperature. Ali *et al.*, 1983 mentioned that the nymphal development of *N. viridula* was shorter at 30°C.

The present study has also shown that the development of the immature stages (duration of the egg + nymphal stage) was affected significantly by constant temperatures. The shortest period was recorded at 32°C (34.45 day), while the longest duration (81.59 days) at 24°C. The previous results supported the data of Ali *et al.*, 1983 and Clercq and Degheele, 1992, who found that, relativity higher temperature around 30°C is the optimum condition for the development of different stages of pentatermid pests. The result, however indicated that the developmental threshold for the period from egg deposition to the adult emergence was about 18°C, consequently the pest requires about 459 day-degrees in order to complete its life cycle. This threshold (18°C) is relatively high as compared with that of the pests inhabiting crops in other agree cosystems. Clereq and Degheele, 1992 recorded lower threshold (10.7 and 11.7°C) for the egg and nymphal development of *Podisus maculiventris* (Penta termidae). Higher developmental threshold of the BMB in this study maybe attributed to the adaptation of the pest to the extremely high temperature prevailing in the New Valley, specially during summer months.

Data of this study indicated that the highest deposited eggs by the BMB was observed at 28°C followed by those at 32°C. This result is in consistent with those of Ali *et al.*, 1983 and Todd, 1989, who found that the highest deposited eggs of *N. viridula* was laid at 30°C.

The calculated biological parameters (Ro, GT, DT, rm and λ) indicate that, temperature of 28 and 32°C seem to be fall in the favorable thermal zone for the biological activity of the BMB, meanwhile, 24°C seems to be outside the favorable range. These results are in accordance with previously findings of Napompeth *et al.*, 1984 and Todd, 1989, who found that the optimum temperature for the development of the pentatomid, *N. viridula* is about 30°C. Ben-Yakir *et al.*, 1996 found that, *C. viduatus* reared indoors at 24±2°C took 5-7 weeks to develop from egg to adult and each pair of bugs gave rize to about 470 new adults over a period of 5 months.

It could be generally concluded, from the obtained data and available literature, that, relatively high temperature (28-32°C) is the optimum condition for development and multiplication of this pest. This information may be useful to predict how fast the population of this pest could develop and give an idea on its population size over a period of time in the New Valley.

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